INSTALLATION RESTORATION PROGRAM

AD-A277 694

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FINAL
REMEDIAL INVESTIGATION

VOLUME I

VOLK FIELD AIR NATIONAL GUARD
CAMP DOUGLAS, WI

SEPTEMBER 1993

HAZWRAP SUPPORT CONTRACTOR OFFICE
Oak Ridge, Tennessee 37831
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Investigation at Volk Field in 1989, 1990 & 1991 to confirm the presence or absence of contamination at 10 sites to determine the extent, degree, and potential contaminant migration is documented in this report. Additionally, An evaluation of risks posed to human health & the environment & remedial action alternatives or future action at two sites was documented. Site investigation involved soil, sediment and/or groundwater monitoring/analysis.

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FINAL

INSTALLATION RESTORATION PROGRAM

REMEDIAL INVESTIGATION

VOLUME I

VOLK FIELD AIR NATIONAL GUARD BASE
Camp Douglas, Wisconsin

SEPTEMBER 1993

Submitted to

NATIONAL GUARD BUREAU
Andrews AFB, Maryland

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LIST OF ACRONYMS AND ABBREVIATIONS

A	Known Carcinogen
ABS	Absorption Factor
AF	Soil-to-Skin Adherence Factor
AFESC	Air Force Engineering Services Center
Ag	Silver
ANGB	Air National Guard Base
API	American Petroleum Institute
ARARs	Applicable or Relevant and Appropriate Requirements
As	Arsenic
ASTM	American Society for Testing and Materials
AT	Averaging Time
atm	atmosphere
AVGAS	Aviation Gas (fuel)
B1/B2	Probable Human Carcinogen
BCE	Base Civil Engineer
Be	Beryllium
BETX	benzene, ethylbenzene, toluene and xylenes
BLS	Below Land Surface
BNA	Base/Neutral/Acids
BPW	Base production well
BW	Body Weight
C	Possible Human Carcinogen
CDI	Chronic Daily Intake
CF	Conversion Factor
C_{inf}	asymptotic concentration in shower air
C_{IS}	analyte concentration in internal standard
CLP	Contract Laboratory Protocol
cm	centimeter
CNS	Central Nervous System
C_r	Concentration Ratio
Cr	Chromium
CRDL	Contract Required Detection Limit
C_s	average concentration of a volatile compound in the shower air; analyte concentration in sample
CS	concentration in soils
C_t	concentration in shower water
Cu	Copper
CW	Concentration in groundwater

LIST OF ACRONYMS AND ABBREVIATIONS-Continued

D	Not Classified (refers to toxicity of compound, i.e., carcinogenic, noncarcinogenic, etc.)
DBC	Dibutylchlorendate
DCE	Dichloroethylene
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
DNR	Department of Natural Resources
DOD	Department of Defense
DOE	Department of Energy
DWEL	Drinking Water Equivalent Level
E	efficiency of release of compounds from water to air
e.g.	for instance
EA	Environmental Assessment
ED	Exposure Duration
EF	Exposure Frequency
EM	Electromagnetic
EPA	Environmental Protection Agency
ES	Engineering-Science, Inc.
ET	Exposure Time; Exploration Technology (refers to monitoring wells installed by ET)
eV	electron volt
°F	degrees Fahrenheit
F_a	flow rate of air in shower
FR	Federal Register
FS	Feasibility Study
ft	foot, feet
F_w	flow rate of water in shower
g	gram
GC	Gas Chromatograph
GC/MS	Gas Chromatography/Mass Spectrometry
GI	Gastrointestinal
gpd	gallons per day
gpm	gallons per minute
GW	ground water
H	Henry's Law Constant
HA	hand auger
HARM	Hazard Assessment Rating Methodology
HAZWRAP	Hazardous Waste Remedial Actions Program
HEAST	Health Effects Assessment Summary Tables
Hg	Mercury

LIST OF ACRONYMS AND ABBREVIATIONS-Continued

HI	Hazard Index
HMTC	Hazardous Materials Technical Center
HPLC	High Pressure Liquid Chromatography
H_r	Height Ratio
i.e.	that is
ID	Inside Diameter
ILUMP	Integrated Land Use Management Plan
IR	Ingestion Rate
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
IS	Internal Standard
JP-4	Jet Fuel
k	rate constant for exponential function
kg	kilogram (10^{+3} grams)
K_{OC}	Organic Carbon Partition Coefficient
L	liter
LC50	Lethal Concentration, 50 percent
LCS	Laboratory Control Sample
LD50	Lethal Dose, 50 percent
m	meter
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg	milligrams (10^{-3} grams)
mmho	millimho (measure of conductivity)
MS	Matrix Spike; Mass Spectrometry
MSD	Matrix Spike Duplicate
MSL	mean sea level
MW	Monitoring Well
n	number of samples
NCP	National Contingency Plan
NGB	National Guard Bureau
NWR	National Wildlife Refuge
OD	Outside Diameter
PA	Preliminary Assessment
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Preventive Action Limit
Pb	Lead
PC	Chemical-specific Dermal Permeability Constant
PCB	Polychlorinated biphenyl
pH	Potential Hydrogen
PID	photoionization detector

LIST OF ACRONYMS AND ABBREVIATIONS-Continued

POL	Petroleum, Oil and Lubricants
ppb	parts per billion (roughly equivalent to micrograms per kilogram or micrograms per liter)
ppm	parts per million (roughly equivalent to milligrams per kilogram or milligrams per liter)
PQL	Practical Quantitation Limit
PR	percent recovery
PVC	Polyvinyl chloride
PZ	piezometer
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
r^2	coefficient of correlation
RA	Remedial Action
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
RfC	Reference Concentration
RfD	Reference Dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
RRF	Relative Response Factor
RSD	Relative Standard Deviation
RT	retention time
S	standard deviation
SA	Skin Surface Area Contacted Per Event
SB	soil boring
Sb	Antimony
SD	sediment sample
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
Se	Selenium
sec	second
SI	Site Inspection
SMCL	Secondary Maximum Contaminant Level
SS	split spoon sample
SOW	Statement of Work
$t_{.95}$	value of t from Student's t-distribution with n-1 degrees of freedom
TBC	To-Be-Considered
TCE	Trichloroethylene, a solvent and suspected carcinogen
TCL	Target Compound List

LIST OF ACRONYMS AND ABBREVIATIONS-Continued

TDS	Total Dissolved Solids
TH	Total Hydrocarbons
Tl	Thallium
TMW	temporary monitoring well
TPH	Total Petroleum Hydrocarbons
t_s	time in shower
TW	temporary well
UCL	Upper Confidence Limit
μg	micrograms (10^{-6} grams)
UST	Underground Storage Tank
V_b	volume of bathroom
VF	Volk Field
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WI	Wisconsin
WIDNR	Wisconsin Department of Natural Resources
WW	water withdrawal (refers to monitoring wells)
yr	year
Zn	Zinc

EXECUTIVE SUMMARY

On behalf of the U.S. National Guard Bureau (NGB) and as a part of the Installation Restoration Program (IRP), a Remedial Investigation (RI) was conducted at Volk Field Air National Guard Base (ANGB), Camp Douglas, Wisconsin. The IRP RI began in October 1987 at Site 1 concurrent with a Site Inspection (SI) of Sites 2, 3, 4, 6, 7, 9, and 10 [Engineering-Science (ES), 1990b, 1990c].

The investigation at Volk Field ANGB continued with two additional field efforts - September-December 1989 and September-December 1990. Limited work was conducted in 1991. This document concentrates on the results obtained from these field efforts. A summary of activities conducted is presented in Table 1. The IRP program focused on ten potentially contaminated sites - nine at Volk Field and one at Hardwood Range. The ten sites are:

- Site 1 - Fire Training Area
- Site 2 - Former Landfill C
- Site 3 - Chronic Fuel Spill Site
- Site 4 - Transformer Fluid Disposal Area
- Site 5 - KC97 Crash Site
- Site 6 - JP-4 Spill Site
- Site 7 - Former Landfill A
- Site 8 - F84 Crash Site
- Site 9 - Former Landfill B
- Site 10 - Munitions Burial Site (Hardwood Range)

Sites 3 and 6 have been consolidated into a single investigative zone due to the proximity of the two sites to one another. This zone is referred to as Site 3/6, Fuel Spill Site.

The purpose of the RI at Volk Field was to:

- confirm the presence or absence of contamination at the sites and (if present) to determine the extent, degree, and the potential for contaminant migration
- evaluate the risks posed to human health and the environment by wastes (if present) and by any soil and groundwater contamination present at the sites

- permit identification and evaluation of remedial action technologies and the development and screening of remedial action alternatives

The methods used in the 1989, 1990 and 1991 RI included:

- soil gas surveys
- geophysical surveys
- soil boring/augering and soil sampling
- piezometer and monitoring well installation and groundwater sampling
- sampling of surface water and sediments
- chemical analysis of soil, sediment, groundwater and surface water.

The monitoring well installation program (1989 through 1991) consisted of the drilling and installation of 30 monitoring wells (including piezometers and temporary wells). Three wells were installed at Hardwood Range and 27 were installed at Volk Field. The wells were installed in either unconsolidated sediments (generally fine to very fine sands) or consolidated sandstone. Local zones of silts and clays were encountered while drilling some of the monitoring wells. The depth to sandstone ranges from the ground surface to approximately 50 feet in the vicinity of Volk Field. At Hardwood Range sandstone occurs at about 75 feet. The unconsolidated sands and sandstone are hydraulically connected and both geologic units have moderate to high hydraulic conductivities.

Groundwater at Volk Field exists at elevations ranging from 986 to 914 feet above mean sea level (MSL), approximately 0 to 35 feet below land surface (BLS). Groundwater flow velocity varies from 0.05 to 2.9 ft/day. At Hardwood Range, groundwater elevations are from 911 to 914 feet above MSL, approximately 9 to 11 feet BLS. The velocity of the groundwater flow is calculated to be 0.07 ft/day.

A baseline risk assessment was performed for each site. The risk assessments were performed using data obtained during the course of the IRP investigation, including the first investigation in 1987 and 1988 and the 1989 and 1990 investigations. Recommendations were made based on the results of the field activities, the risk assessments and the comparison of analytical results to Applicable or Relevant and Appropriate Requirements (ARARs).

RESULTS

The chemical constituents detected (all investigations) at levels exceeding ARARs are presented in Table 2. ARARs exceeded include the Wisconsin Department of Natural Resources Enforcement Standards and Federal Maximum Contaminant Levels and state and federal surface water criteria. The results of the IRP investigations are summarized below.

Site 1

The soils at Site 1 contain volatile, semivolatile and inorganic compounds. The soil contamination is primarily limited to the area of the burn pit investigated in 1987. Groundwater contains volatile organics, semivolatile organics and inorganics. Free product was detected in some of the wells located at Site 1. ARARs were exceeded for benzene, lead, pentachlorophenol, toluene, trichloroethylene and xylenes. The extent of the contaminant plume has been defined. Unacceptable health risks were identified for the ingestion and inhalation of volatiles in contaminated groundwater. However, the groundwater exposure pathways at this site are for hypothetical residents and are not complete.

Site 2

At Site 2, the surface soils contain volatile organics, semivolatile organics, pesticides and inorganic compounds. Surface water ARARs were exceeded for lead, mercury, thallium and zinc. These metals are not thought to be present as a result of activities at the site. No current or future health risks were identified and risks to ecological receptors are low.

Site 3/6

Soil and groundwater at Site 3/6 have been impacted by fuel handling activities. The soils contain volatile organic compounds and total petroleum hydrocarbons (TPH). A thin layer of free product was observed in a groundwater sample taken from one temporary monitoring well. Compounds detected in groundwater which exceeded ARARs include benzene, toluene and xylenes. The volatiles in groundwater are limited to the Petroleum Oils and Lubricants (POL) Storage area. Unacceptable health risks were identified for the ingestion and inhalation of volatiles in contaminated groundwater. However, the groundwater exposure pathways at this site are for hypothetical residents and are not complete.

Site 4

Contaminants were not detected at Site 4, therefore no unacceptable risks were identified.

Site 5

The soils at Site 5 contain volatile organics, TPH and lead. None of the chemical concentrations exceed identified criteria. No contamination was found in the groundwater samples collected at Site 5. No current or future health risks were identified.

Site 7

No organic contaminants were detected at Site 7. Arsenic, cadmium, chromium and lead levels from unfiltered groundwater samples exceeded ARARs. No

dissolved metals were found exceeding ARARs. No current or future health risk were identified.

Site 8

Contaminants were not detected at Site 8, therefore no unacceptable risks were identified.

Site 9

At Site 9, surface soils contain pesticides, semivolatile organic compounds and metals. Compounds detected in groundwater which exceeded ARARs include cadmium and silver. Dissolved cadmium was detected once; silver was detected in one unfiltered groundwater sample. An unacceptable health risk was identified for the ingestion of groundwater containing cadmium. However, the groundwater exposure pathway is for hypothetical residents and is not complete.

Site 10

The surface soils at Site 10 contained only metals. Groundwater at this site contained volatile and semivolatile organics, TPH and metals. Compounds detected in groundwater which exceeded ARARs include benzene and chloroform. Bis(2-ethylexyl)phthalate in surface water also exceeded an ARAR. An unacceptable health risk was identified for the inhalation of benzene from groundwater during showering. However, the groundwater exposure pathway is for hypothetical residents and is not complete. The extent of the contaminated groundwater has been defined.

RECOMMENDATIONS

The following recommendations are based upon data collected during the IRP investigations and the baseline risk assessments performed for each site. Recommendations for the ten sites include:

- **Site 1**: Perform a feasibility study to evaluate alternatives for remediating soil and groundwater contamination.
- **Site 2**: Prepare a No-Further-Action Decision Document.
- **Site 3/6**: Perform a feasibility study to evaluate alternatives for remediating soil and groundwater contamination.
- **Site 4**: Prepare a No-Further-Action Decision Document.
- **Site 5**: Prepare a No-Further-Action Decision Document.
- **Site 7**: Prepare a No-Further-Action Decision Document.
- **Site 8**: Prepare a No-Further-Action Decision Document.
- **Site 9**: Monitor for the presence of cadmium in groundwater. The results should be used to evaluate the risk to human health. If significant levels of

cadmium are not detected, prepare a No-Further-Action Decision Document.

- **Site 10:** Perform a feasibility study to evaluate alternatives (including no further action).

TABLE 1
SUMMARY OF IRP ACTIVITIES CONDUCTED IN 1989 , 1990 AND 1991
VOLK FIELD ANGB, WI

Site	Geophysics Survey	Soil Gas Survey	Exploratory Hand Augering	Total Soil Borings	Monitoring Well Installation	Soil Samples	Groundwater Samples	Surface Water Samples
1	Yes	84 points		17	9	37	31	
2			13 borings	18	1	5	5	5 (1)
3/6			38 borings	57	9	23	17	
4				3		7		
5		93 points		11	1	16	3	
7			12 borings		3		7	
8				2	4	4	2	
9	Yes			3		3	3	
10				3	3	3	12	3

(1) Four sediment samples were collected at Site 2 in 1991.

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TABLE 2
CHEMICAL CONSTITUENTS DETECTED
WHICH EXCEED CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Site Number	Maximum Detected Concentration	Criterion	Criterion Value
Groundwater (ug/L)				
Arsenic	7	55 (1)	MCL/WIDNR	50
Benzene	1	8,270	MCL/WIDNR	5
	3/6	2,200		
	10	167		
Cadmium	7	29 (1)	MCL	5
	9	10.2		
Chloroform	BPW	86	WIDNR	6
	10	15		
Chromium (VI)	7	100 (1)	WIDNR	50
Lead	1	270	MCL	15
	BPW	27.94		
	7	46 (1)		
Pentachlorophenol	1	76	MCL	1
Silver	9	180 (1)	WIDNR	50
Toluene	1	12,700	WIDNR	343
	3/6	4,900		
Trichloroethylene	1	79	MCL/WIDNR	5
Xylenes	1	1,800	WIDNR	620
	3/6	1,800		
Surface Water (ug/L)				
Bis(2-ethylhexyl)phthalate	10	35	FAWQC (HH)	5.9
Lead	2	22	FAWQC	3.2
Mercury	2	0.34	FAWQC	0.012
Thallium	2	120 (1)	FAWQC (HH)	7.2
Zinc	2	99.4	WIDNRSW	62.69

MCL - Safe Drinking Water Act Maximum Contaminant Level.
WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.
WIDNRSW - Wisconsin Department of Natural resources Surface Water Criteria
FAWQC - Federal Ambient Water Quality Cietrion for Freshwater Aquatic Life, chronic concentration.
FAWQC (HH) - Federal Ambient Water Quality Criterion for Human Health, consumption of organisms.
BPW - Base Production Well
(1) - Unfiltered sample; detected concentration not used in risk assessment.

SECTION 1
INTRODUCTION

The Department of Defense (DOD) has developed a program to identify and evaluate sites on DOD property where contamination may be present due to previous spills or hazardous waste disposal practices, to control the migration of hazardous contaminants and to control hazards to health, welfare, and the environment that may result from contamination at these sites. This National Guard Bureau (NGB) program is called the Installation Restoration Program (IRP). The NGB contracts with Martin Marietta Energy Systems to assist in implementing the IRP through an Interagency Agreement between the United States Air Force and the Department of Energy (DOE). Under the IRP, Engineering-Science, Inc. (ES) entered into an agreement with Martin Marietta Energy Systems under General Order contracts (General Order Number 18B-973876, Task Order X-04 and General Order Number 96B-9977886, Work Release Authorization Number K-01) to conduct a Remedial Investigation (RI) at Volk Field Air National Guard Base (ANGB) (hereafter referred to as "the Base") and Hardwood Air-to-Ground Range (also under the control of the Base). This investigation was conducted using Hazardous Waste Remedial Actions Program (HAZWRAP)/DOE documents 65/RI, 69/RI, and 100 as guidance. The objective of the IRP for Volk Field is to confirm the presence or absence of contamination and to evaluate the potential for migration of contaminants from nine sites at the Base and one site at Hardwood Range.

This report presents the results of the investigation performed at the ten sites in 1989, 1990 and 1991:

- Site 1 - Fire Training Area
- Site 2 - Former Landfill C
- Site 3 - Chronic Fuel Spill Site
- Site 4 - Transformer Fluid Disposal Area
- Site 5 - KC97 Crash Site
- Site 6 - JP-4 Spill Site
- Site 7 - Former Landfill A
- Site 8 - F84 Crash Site

- Site 9 - Former Landfill B
- Site 10 - Munitions Burial Site (Hardwood Range)

Section 1 of this report presents background information on the Base and Hardwood Range, and summarizes previous IRP investigations conducted at the ten sites. Section 2 summarizes the physical characteristics of the study area. Section 3 describes procedures used in the field investigations. Section 4 presents the procedures used during the risk assessment and ecological assessment, a discussion of Applicable or Relevant and Appropriate Requirements (ARARs) and characteristics and properties of the contaminants identified during the investigation. Sections 5 through 13 present the site descriptions, site-specific field activities, results of the investigations, baseline risk assessment, conclusions and recommendations. A summary of conclusions, and recommendations for future work are presented in Section 14. A compendium of references has been provided in Section 15. Appendix A contains definitions, nomenclature, and units of measurement while hydrogeologic support data (including lithologic logs) are found in Appendix B. Detailed descriptions of the geophysical and soil gas investigations are presented as Appendices C and D, respectively. Appendix E contains the QA/QC report which includes the summarized analytical data. Toxicity profiles for the chemicals of concern in the baseline risk assessment are provided in Appendix F. A summary of the analytical results obtained in earlier investigations [ES, 1990b, 1990c] is presented in Appendix G. The raw analytical data have been compiled by ES into two volumes titled *Remedial Investigation Report Volume III and IV; 1989, 1990, and 1991 Analytical Data, Volk Field Air National Guard Base, Camp Douglas, Wisconsin, February 1992.*

BACKGROUND INFORMATION

The Base is located approximately 90 miles northwest of Madison, Wisconsin in Juneau County (Figure 1.1). It is located in Township 17N and Range 2E. The Base is one of four Combat Readiness Training Centers for the Air National Guard. The mission of the Base is to provide an effective, realistic environment for military units to accomplish combat training. Camp Williams, the site of the Wisconsin Army National Guard State Maintenance Office, is located adjacent to the Base. Also located at Camp Williams is the United States Property and Fiscal Office of the Wisconsin National Guard. To the north and east of the Base lie rural and agricultural lands. The town of Camp Douglas is situated south and west of the Base.

The Base originated in 1886 as a training location for the Wisconsin National Guard. The Base was referred to as Camp Douglas from that time until 1926 when it was formally named Camp Williams. In 1947 Camp Williams expanded to include an airfield and was utilized as a training location for Air Guard units from Madison and Milwaukee. From 1950 on, it has also been utilized by units from other states.

Following a lease arrangement with the Federal Government in 1954, the facilities at Camp Williams were further upgraded, including the addition of Hardwood Range. In 1957 Camp Williams was officially re-named Volk Field. Since then the Base has been continuously updated to accommodate improved technologies and requirements of the visiting training units. With a reduction in the total number of ANG training sites from eight to four (presently), utilization of the facilities at the Base and Hardwood Range has increased significantly.

Hardwood Range is located approximately 25 miles northeast of the Base, near the town of Finley in northeastern Juneau County. It is located in Township 20N and Range 4E. Hardwood Range is operated by Base personnel as a training facility for aerial weapons deliveries within a controlled environment.

SUMMARY OF PREVIOUS IRP ACTIVITIES

The IRP remedial action process consists of the following:

- Preliminary Assessment (PA)
- Site Inspection (SI)
- Remedial Investigation (RI)
- Feasibility Study (FS)
- Remedial Design (RD)
- Remedial Action (RA)

The Preliminary Assessment of Volk Field was completed by the Dynamac Corporation under contract to Hazardous Materials Technical Center (HMTC) [HMTC, 1984]. Fifteen sites were identified during the PA. Eight of the identified sites were ranked using the United States Air Force Hazard Assessment Ranking Methodology (HARM) as having a potential for migration of contaminants. Two additional sites were identified later, increasing the total number of sites to ten [HMTC, 1986].

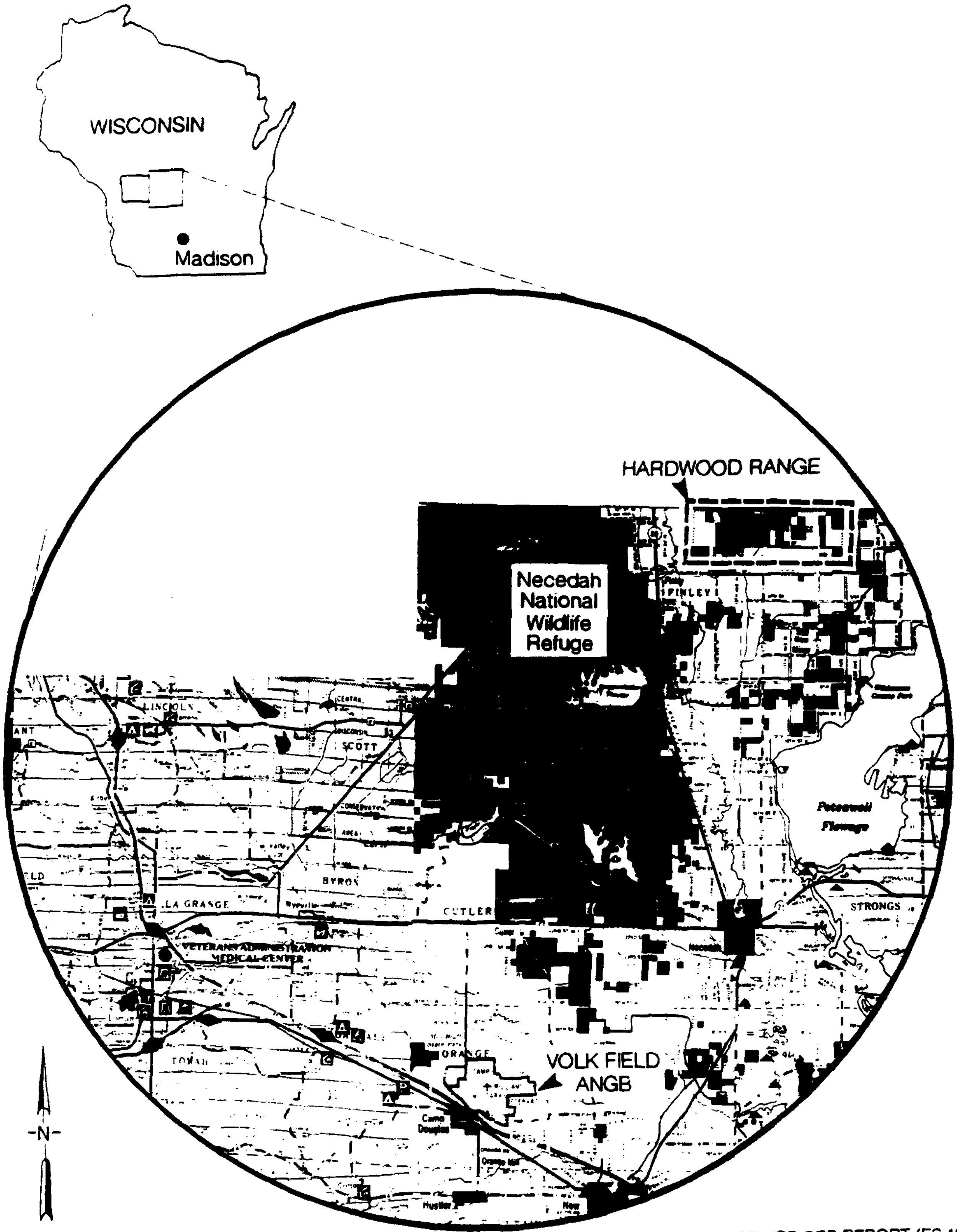
A SI of seven sites of the eight sites (Sites 2, 3/6, 4, 7, 9 and 10) was conducted between 5 October 1987 and 7 May 1988 by Engineering-Science, Inc. The results of this investigation are provided in the Site Investigation Report [ES, 1990c]. During this same time period, ES conducted an RI at Site 1, Fire Training Area [ES, 1990b]. Based on the recommendations presented in these two documents, ES developed a Work Plan [ES, 1990d] for completion of the field investigations to gather data to complete the SI and RI at these sites. Two additional sites (Sites 5 and 8) were added to the scope of the IRP effort [ES, 1990e]. An Addendum to the Work Plan was prepared for the field activities conducted at Site 8. The Work Plan and Addendum to the Work Plan included provision for conducting the follow-on field investigations. These investigations were completed in the fall of 1989 and 1990. Field activities conducted in 1991 were executed according to general

procedures outlined in the 1990 Work Plan. This report presents the results of the 1989, 1990 and 1991 field efforts.

Results from the 1987 field investigations are incorporated in this document where required. The following data obtained during the 1987 investigations were utilized in the Risk Assessment: soils and groundwater data from Sites 1 [ES, 1990b] and 3/6 [ES, 1990c], groundwater and surface water data from Site 2 [ES, 1990c], soils data from Site 4 [ES, 1990c] and groundwater data from Sites 7, 9 and 10 [ES, 1990c]. These 1987 data are presented in Appendix G. These data are also included in the site-specific summary tables found at the end of Sections 5 through 13.

AREA LOCATION MAP

VOLK FIELD ANGB, WI



NOT TO SCALE

SOURCE: IRP CRP REPORT (ES 1991)

AT077DWG

ES ENGINEERING-SCIENCE

SECTION 2
ENVIRONMENTAL SETTING

The Base and Hardwood Range are located in central Wisconsin, between Madison and Wassau. The Base covers about 2,500 acres while Hardwood Range consists of 7,680 acres.

GEOGRAPHIC SETTING

The Base is approximately 90 miles northwest of Madison, WI, in Juneau County. The Village of Camp Douglas, Wisconsin, with a population of approximately 580, is located immediately southwest of the Base. The Base lies at an average elevation of 905 feet above mean sea level (MSL). The air field at the Base consists of a main runway, measuring 9,000 feet in length, and two inactive runways, 4,483 feet and 1,960 feet in length. The undeveloped portions of the Base are heavily wooded and used for various training exercises. Overall, the Base is flat with marshy areas located to the north of the airfield and along the southeastern boundary of the Base. These low areas are separated from the developed portion of the Base by a sandstone bluff that rises approximately 200 feet above the surrounding areas.

Hardwood Range is located approximately 25 miles northeast of the Base, near the town of Finley in northeastern Juneau County. Hardwood Range is at an average elevation of 960 feet above MSL. The facilities consist of various targets and patterns used in the bombing exercises, three control towers, two garages and one administrative building. These facilities are connected by a number of unpaved roadways. The entire area is flat and much of it is wetlands.

METEOROLOGY(1)

The climate in the area of the Base is generally classified as having wide and frequent variations in temperature. Typically, the winters are cold and humid and summers are warm with moderate humidities. Occasionally during the summer there are periods of hot and humid weather that may last up to a week. Table 2.1 provides a summary of monthly temperature and precipitation data in the study area. Table 2.2 provides the dates of the first and last freezing temperatures. This

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(1) The information presented in this section was prepared by the National Climatic Center, Asheville, North Carolina and was taken from a preprint of the Juneau County Soil Survey, to be published by the National Cooperative Soil Survey. Additional information was taken from the Installation Restoration Program - Record Search, HMTC, 1984.

data and the discussion below are based on information recorded in 1951 through 1981 at Mauston, Wisconsin, located approximately 15 miles southeast of Volk Field.

In winter, the average temperature is 19°F and the average daily minimum temperature is 8°F. The lowest temperature on record, which occurred at Mauston on January 15, 1963, is -36°F. In summer, the average temperature is 69°F and the average daily maximum temperature is 82°F. The highest recorded temperature, which occurred at Mauston on August 21, 1955, is 102°F.

The average annual precipitation is 33 inches. Of this, 23 inches, or 70 percent, usually falls from April through September. In two years out of ten, the rainfall in April through September is less than 18 inches. The heaviest one-day rainfall during the period of record was 3.78 inches at Mauston on August 1, 1953. Thunderstorms occur on approximately 40 days each year, primarily during the summer months. The average seasonal snowfall is 52 inches. The greatest continuous snowfall for the period of record is 31 inches. On the average, 48 days a year have at least 1 inch of snow on the ground. However, the number of days with snow cover varies greatly from year to year. It has been estimated 10 inches of precipitation are available for runoff and groundwater recharge after evapotranspiration (water removed by direct evaporation and by transpiration of plants).

The average relative humidity in mid-afternoon is about 60 percent. Humidity is higher at night and the average humidity at dawn is about 80 percent. The sun shines 65 percent of the time in summer and 45 percent in winter. The prevailing wind is southerly in the summer and westerly in the winter. Wind speeds are highest in the spring and average 10 miles per hour.

GEOLOGY

Both the Base and Hardwood Range are within the Wisconsin Central Plain physiographic province, a subsection of the Central Lowlands physiographic province of the United States. This part of the Central Plain is characterized by flat or gently undulating topography. Relief is generally low except for the sandstone buttes located near the Base. These buttes rise 100 to 300 feet above the surrounding lowlands.

Regional Geology

The geologic processes responsible for the formation of the rock units which comprise the Central Lowlands began during the Cambrian Period (505-570 million years ago). During this Period, differential uplift and subsidence occurred throughout Wisconsin and much of the North American Continent, causing the areas which subsided to become inundated by encroaching seas and the uplifted portions to be eroded. The uplifted areas were primarily composed of granite and undifferentiated igneous and metamorphic rocks.

North-central Wisconsin is part of the uplifted area called the Wisconsin Arch. Along the flanks of this arch, ancient seas deposited sediments similar to those currently being deposited along the continental margins of the United States. Subsequent lithification (process of turning sediment into rock) created sandstone out of the ancient beach and nearshore sand deposits. A portion of these sandstone units are exposed in the bluffs surrounding the Base. These sandstones are Cambrian and include (from oldest to youngest) the Mt. Simon, Eau Claire and Wonewoc Formations.

The process which exposed the Cambrian sandstones at the Base was a final period of uplift along the Wisconsin Arch. This uplift occurred during the Permian Period (245-285 million years ago), initiating a long period of erosion which continues today. Beginning approximately 50 miles north of the Base and extending northward, this erosion has exposed the Precambrian core of the Wisconsin Arch. Figure 2.1 is a generalized geologic map of Wisconsin which illustrates the location of the Precambrian rocks and the overlying younger sedimentary rocks. Also on Figure 2.1 is a diagram of an east-west oriented geologic cross-section which illustrates the domed structure of the Wisconsin Arch and the position of the Cambrian and younger rocks along the flanks [HMTC, 1984].

Both the Precambrian core (granites and undifferentiated igneous and metamorphic rocks) and the Cambrian sandstones described above occur at the Base. The geologic history of these rock groups provides some indication of their hydrogeologic characteristics (e.g., porosity and degree of fracturing). These characteristics are discussed in detail in the following subsections.

Local Geology

The geologic formations that directly underlie the Base and Hardwood Range are predominantly fine to coarse-grained sandstones with interbedded shales overlain by unconsolidated sand, silt and minor amounts of clay, as described in Table 2.3. These sediments rest on Precambrian core rocks mentioned above. The Quaternary deposits vary in thickness from less than 40 feet in the vicinity of the Base to 75 to 150 feet in the vicinity of Hardwood Range. These deposits resulted from glaciers which developed during the Pleistocene Epoch (less than two million years ago). Although neither the Base nor Hardwood Range were directly covered by glaciers, they were located close enough to ice masses situated to the north and east to be covered by ice-related geologic deposits. When the glaciers began to retreat, large inland lakes were formed near the perimeters of the receding glaciers. Within these lakes, sand, silt and clay were deposited from streams and rivers carrying melt water and sediment. Figure 2.2 illustrates the boundaries of the major glaciers relative to the present study areas and the locations of glacial lake sediments. The glacial lake sediments at the Base and Hardwood Range were deposited within an 1,800-square mile Pleistocene lake referred to as Lake Wisconsin. Because the Base is near the western boundary of this ancient lake, the

unconsolidated sediments here are not as thick as at Hardwood Range, which is more centrally located within the ancient Lake Wisconsin [HMTC, 1984]. Borehole logs for the Camp Douglas Emergency Fire Well drilled near the Base are interpreted as encountering the unconsolidated sediments to a depth of 55 feet and the sandstone and shales of the Mt. Simon Formation from 55 to 250 feet below the ground surface. The drilling record for this borehole was published in the SI Report [ES, 1990c]. Below this, approximately 20 feet of Precambrian granite was encountered. No mention was made on the borehole log regarding bedrock fractures; however, rock outcrops in the vicinity of the Base exhibit vertical fracturing.

Soil boring records (Appendix B) from the Base and Hardwood Range concur with the regional geologic conditions described above. A generalized stratigraphic sequence developed from boring logs is shown on Figure 2.3. At the Base, all borings encountered unconsolidated Quaternary sands to a depth of approximately 15 feet below the ground surface. The unconsolidated materials are typically yellowish, fine to very fine quartz sand with only a trace of silt-sized particles present. No accessory minerals were visible. At some locations, a clay or silty clay less than 5 feet in thickness was encountered. These clays are interpreted as deposits from Lake Wisconsin. This clay is reddish-brown, laminated and contains varying amounts of silt. The clay laminae are separated by thin layers of very fine sand. The unconsolidated sands at Hardwood Range are at least 75 feet thick according to drilling records obtained from the Wisconsin Geologic and Natural History Survey. Below the unconsolidated deposits at the Base is the Mt. Simon Formation (sandstone) [Lee Clayton, personal communication]. Where encountered, this sandstone is nearly indistinguishable from the overlying unconsolidated sands except in the degree of consolidation. This sandstone drills easily, is poorly cemented and is very friable. The sandstone was not encountered during the ES field investigation at Hardwood Range.

Soils

The soil types at the Base are generally classified as marshy, sandy soils. The soils are moderately to excessively drained and have high permeabilities. These soils formed in outwash, lacustrine or aeolian deposits. In low-lying areas, soils are poorly drained and contain large amounts of organic matter. These soils formed on outwash plains and in the basins of glacial lakes [Preprint of Soil Survey, Juneau County, Wisconsin, 1988].

Most of the soil at the Base is fine sand. The upper eight inches of soil is very fine with some organic matter making it slightly loamy. This soil is loose with no structure and is often wind blown. The subsoil consists of a loose, fine sand that is often yellow in color. There is no gravel in the subsoil and the amount of silt is very small. In other areas, the surface soil is yellowish-brown or gray in color and consists of fine sand containing a small amount of organic matter. This surface soil

is approximately six inches thick with organics concentrated in the upper one inch. This topsoil is also wind blown. On and near the sandstone buttes, a thin soil is present which is low in organic matter and contains fine sand and medium to large rock fragments (talus) derived from the nearby buttes.

In low-lying areas the soils are generally sandy with shallow peat lenses (vegetable matter in various stages of decomposition). The peat occurs to a depth of 30 inches below the ground surface. The subsoil is usually fine sand which is white in color and often stained with iron or slightly mottled. In areas where standing water occurs, the surface soil is a black organic-rich muck with fine sand and silt [HMTC, 1984].

HYDROGEOLOGY

Groundwater is an important resource throughout Wisconsin. Water exists in both the unconsolidated Pleistocene deposits and the underlying Cambrian sandstone units and presumably, in the Precambrian metamorphic and igneous rocks that underlie the sedimentary sequence. The following subsections provide a discussion of the regional hydrogeology and the hydrogeology at the Base and Hardwood Range.

Regional Hydrogeology

Groundwater within the Pleistocene deposits is contained within the pore spaces between individual particles. Groundwater in the Cambrian sandstone occurs in the pore spaces and to a lesser extent in secondary fractures that developed after the rock was formed. Water in these deposits originates as recharge from precipitation and infiltration. Water within the deeper Precambrian units occurs almost exclusively within the secondary fractures and openings.

Recharge to these formations is from surface water infiltration, precipitation and snow melt. Depletion of this stored water, resulting in a lowering of the water table, is the result of natural discharge to streams and swamps, pumping from wells installed in the aquifers and from evapotranspiration.

The effect of recharge and discharge on water levels in this area is demonstrated on Figure 2.4. The upper part of Figure 2.4 shows the monthly measurements of the depth to the water table from 1950 to 1966 for a well located at the Base. This graph clearly shows a consistent rise of the groundwater table during years of above normal rainfall and snow. Water level decline follows years of lower than normal rainfall; therefore, long-term trends in the water levels can be attributed to variation in the total annual precipitation (for example, 1957 and 1958) as shown in the lower part of Figure 2.4. Seasonally, groundwater levels rise during early spring and summer months as a result of snow melt and rainfall.

In Juneau County, groundwater movement generally follows topography and discharges into major drainage features. Figure 2.5 shows a generalized

groundwater contour map for Juneau County including the Base and Hardwood Range. Flow is generally toward the Lemonweir River in the vicinity of the Base. Regional groundwater flow at Hardwood Range is from the north to south towards the Petenwell Lake.

Site Hydrogeology

In the area of the Base the major aquifers are the Pleistocene glacial deposits and the underlying Cambrian sandstones. Most of the groundwater is derived from the deeper Cambrian sandstones as the majority of the municipal wells are screened within this formation. Water is also obtained from the glacial deposits which are generally less than 40 feet thick. At Hardwood Range most groundwater is derived from the glacial deposits due to the greater depth to the sandstones. Both aquifers generally produce moderate yields of 500-1,000 gallons per minute of good quality water [Golden Sands Resource Conservation and Development Area, 1981].

The well records examined by ES for this study do not indicate the presence of any laterally extensive, low permeability materials near the contact between the glacial deposit and sandstone. This suggests the two geologic formations are hydraulically connected and water is free to move vertically depending on the gradient at a particular location. At the Base, Harloff [1942] reported relatively thin clay or silty clay layers in the glacial deposits. These layers are generally less than 5 feet thick. Near Hardwood Range the clay layers vary from 2 to 17 feet thick but average less than 10 feet. The clays are interpreted as lacustrine deposits of historic Lake Wisconsin. The clays are generally reddish in color, occur in thin layers in places, are varved and sometimes massive. The extent of the effect these clays have on the vertical movement of groundwater is unknown but the effect should be limited due to the thinness of the clay layers. Although these clays are not considered as a continuous confining layer, they may produce locally perched water table conditions or semi-confined aquifers [Harloff, 1942].

Figure 2.6 is a Base-wide groundwater contour map constructed from elevations measured on 13 November 1990. Groundwater flows northeast at Sites 1, 3/6 and 7. The flow of groundwater at Site 2 is toward the east-southeast. Groundwater flow at Sites 8 and 9 is toward the north and north-northeast, respectively. Groundwater gradients in the area of the Base range from 0.0004 to 0.005 ft/ft. The water elevations used to create Figure 2.6 including land surface and bedrock elevations and well construction details are presented in Table 2.4. Groundwater flow at Hardwood Range is toward the south and southeast (Figure 2.5) with a gradient of approximately 0.001 ft/ft. Flow at both areas corresponds to the regional groundwater flow patterns discussed in the Regional Hydrogeology section.

Vertical gradients in the water table aquifer provide information regarding recharge and discharge areas. Whether recharge or discharge is occurring at a particular location is important when considering contaminant migration. Downward migration of contaminants is unlikely in areas where discharge of

groundwater (upward gradient) is occurring. The vertical gradient at a particular location is determined by installing well clusters which allow for the measurement of hydraulic head at different depths. For example, a well cluster installed at Site 2 (1988) indicates a vertical upward gradient of approximately 0.004 ft/ft between wells VF2 MW-5 and VF2 MW-3. This gradient potential is discussed further in Section 6. Appendix B provides a summary of groundwater data obtained during this investigation. Included are tables presenting the horizontal and vertical gradients for the various sites as well as groundwater contour maps developed for a number of groundwater measurements events.

The hydraulic characteristics of the shallow aquifer at the Base were determined from an aquifer pumping test conducted in 1988 at Site 1 [ES, 1990b]. Data from this test indicate the aquifer is unconfined with an apparent storage coefficient of 0.05. The apparent hydraulic conductivity is 800 gallons per day per foot squared (gpd/ft^2) or 107 ft/day (4×10^{-2} cm/sec). Using an average hydraulic gradient of 0.002 ft/ft and an effective porosity of 0.20 [Bouwer, 1978], the average groundwater flow velocity estimated for the Base is 1.07 ft/day.

Location of Existing Wells

Water supply wells and private water wells are located at both Volk Field and Hardwood Range. Six wells are located on the Base that are, or were, used for water supplies. The locations of the six Base production wells are shown on Figure 2.7. Table 2.5 summarizes the available construction information on these water supply wells and two wells at Hardwood Range. Well construction records for wells located on the Base and Hardwood Range were obtained from the Wisconsin Geologic and Natural History Survey.

The village of Camp Douglas south of the Base has a public water supply well and distribution system. Camp Douglas residents occasionally receive drinking water from the Base distribution system when repairs or maintenance is required on the Camp Douglas system. It is possible that private wells also exist within the Village of Camp Douglas. Private residents outside the Village of Camp Douglas have no public water supply system and receive drinking water from private wells. Figure 2.8 shows the locations of residents and other major structures (mostly farm buildings) in the vicinity of the Base. These locations were obtained from a map used by emergency officials. It is expected that most of these locations have a private well from which drinking water is obtained. The locations of private residents' wells in the vicinity of Hardwood Range is shown on Figure 2.9. This figure also shows the location of the two water supply wells at Hardwood Range.

The six Base production wells were scheduled to be sampled during this investigation. However, well W-6 is no longer in use and wells W-3 and W-5 were not operational and could not be sampled. The operational wells W-1, W-2 and W-4 were sampled for halogenated volatiles, aromatic volatiles, total petroleum hydrocarbons, semivolatile organics and the 13 priority pollutant metals. These

analytical results are presented on Table 2.6. Also presented on this table are the results obtained from well VF92 MW-1 which was installed at the Base boundary. VF92 MW-1 is located about 1,900 feet north of the eastern end of the east-west runway as shown on Figure 2.6.

No volatile organics, semivolatile organics, TPH or dissolved priority pollutant metals were detected in samples from W-4, the Base production well east-northeast of Site 1, or from VF92-MW1. TDS were found in all of the sampled Base production wells and the Base boundary well. Wells W-1 and W-2 were shown to contain additional constituents. Samples from W-1 contained copper, zinc and lead at 269, 72.2 and 27.9 μg/L, respectively. Chloroform at 86 μg/L and zinc at 1,160 μg/L were detected in the sample from W-2. The detected concentrations for lead and chloroform are above standards presented later in this document (Section 4). The significants of these results is presented in Section 14, Summary of Results and Conclusions.

SURFACE-WATER HYDROLOGY

The Base is located within the drainage basin of the Lemonweir and Little Lemonweir Rivers (Figure 2.10). The Lemonweir River flows from northwest to southeast and is located approximately 3,700 feet northeast of the Base boundary. The Little Lemonweir River is approximately 1.5 miles south of the Base boundary and flows from west to east. The Little Lemonweir joins the Lemonweir River 4.5 miles southeast of the Base, at the town of New Lisbon. New Lisbon and Mauston are the only major communities on the Lemonweir River downstream of the Base. Neither of these towns uses surface water for municipal water supplies.

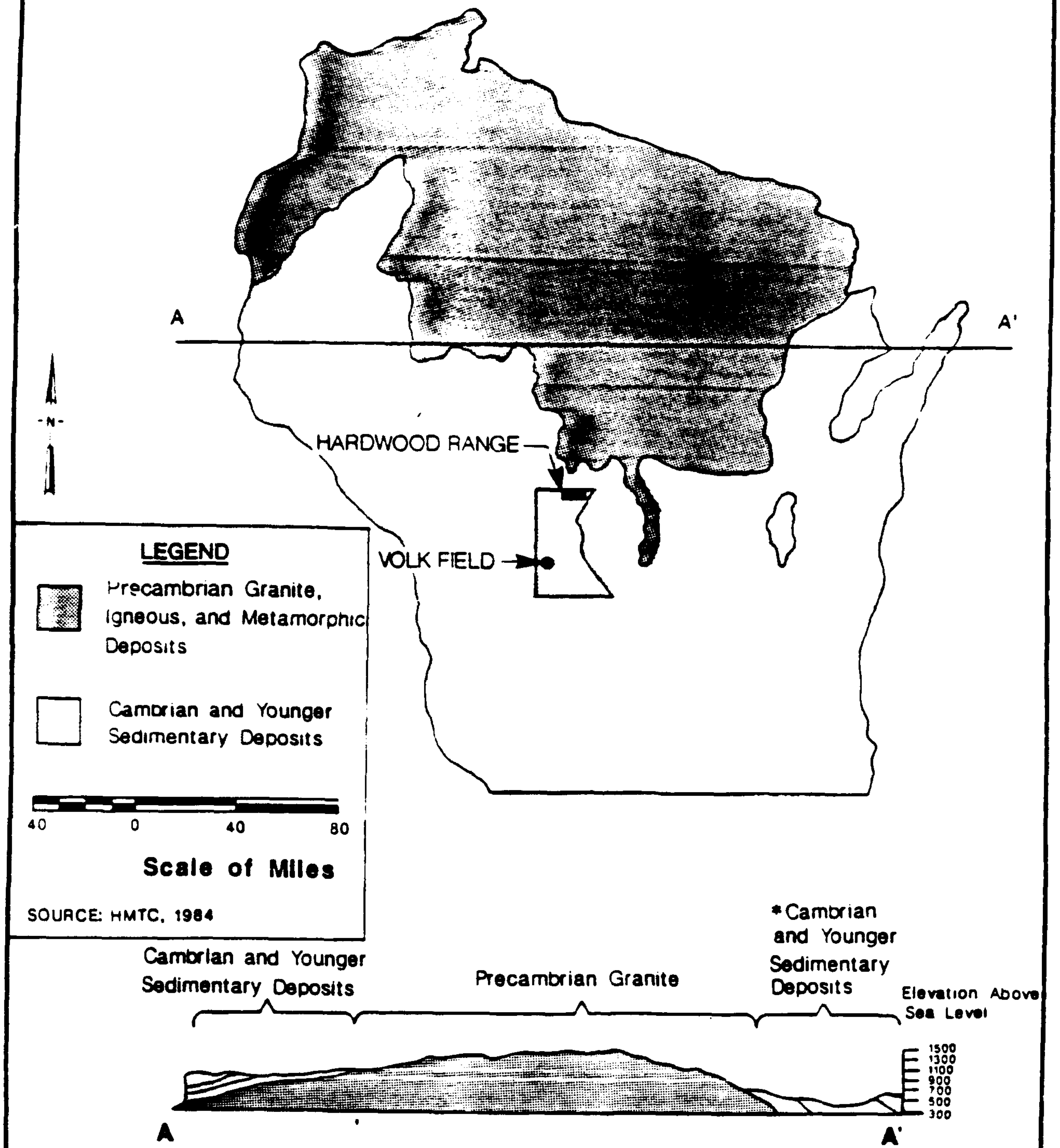
Figure 2.11 illustrates the directions of surface water runoff at the Base. Runoff is facilitated by a system of ditches which drain toward the south and east. These drainage ditches lead directly to either the Lemonweir River or the Little Lemonweir River.

Hardwood Range is within the drainage basin of the Yellow River which joins the Wisconsin River approximately 25 miles south of Hardwood Range. Large areas within Hardwood Range are poorly drained swamps. Locally the area is dissected by various manmade and natural channels which flow primarily toward the south into the Cranberry Creek and Yellow River. Necedah, a town downstream from Hardwood Range, is located 13 miles south along the Yellow River. Figure 2.12 illustrates the directions of surface drainage at Hardwood Range, determined by field reconnaissance of the Range and interpretation of topographic maps [HMTC, 1984].

Figure 2.1

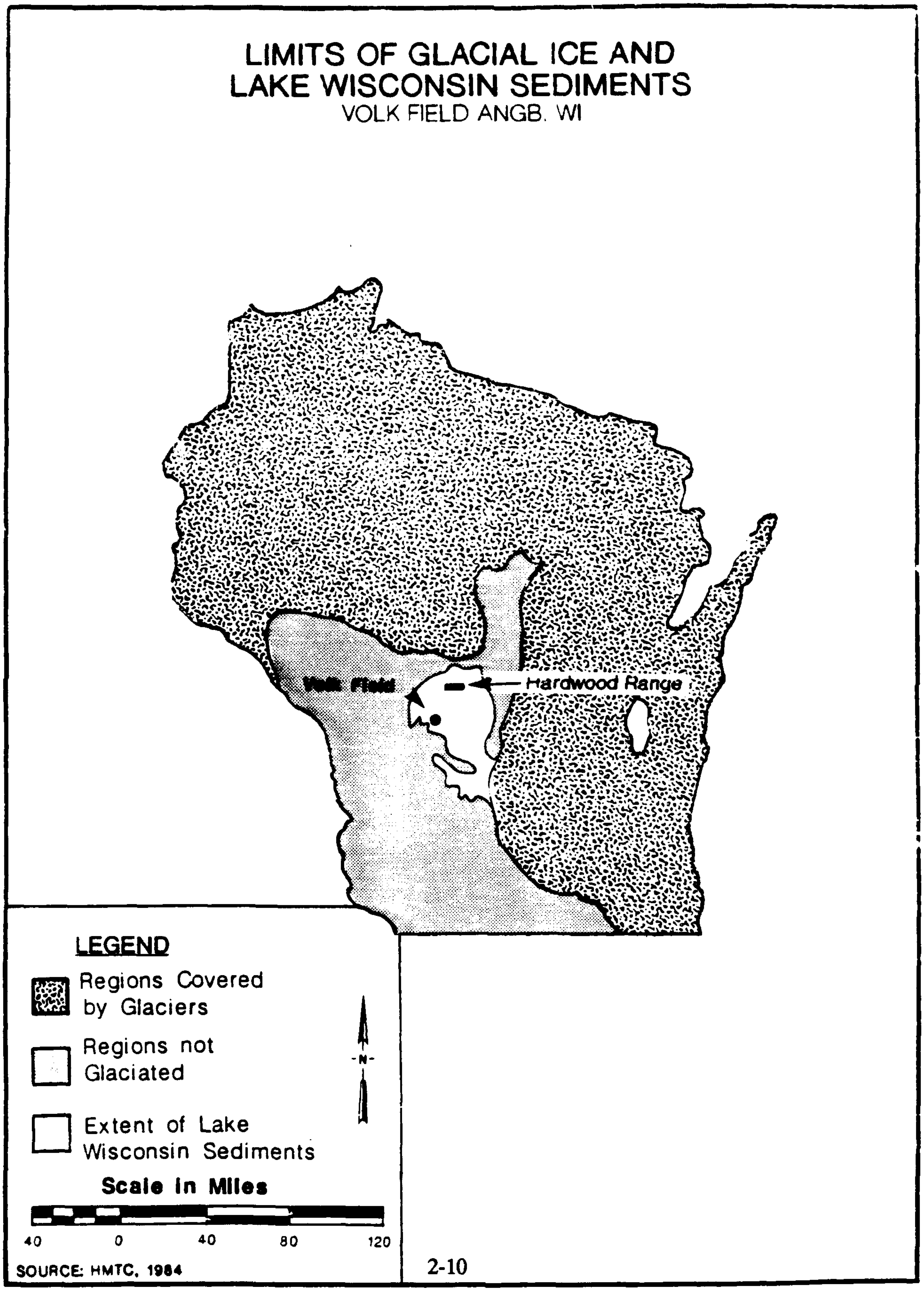
GENERALIZED GEOLOGIC MAP AND GEOLOGIC CROSS-SECTION OF WISCONSIN

VOLK FIELD ANGB, WI



*Subdivisions denote orientations of bedding planes, only.

Figure 2.2


LIMITS OF GLACIAL ICE AND
LAKE WISCONSIN SEDIMENTS
VOLK FIELD ANGB, WI
Volk Field
Hardwood Range
LEGEND
Regions Covered by Glaciers
Regions not Glaciated
Extent of Lake Wisconsin Sediments
N
Scale In Miles
40
0
40
80
120
SOURCE: HMTC, 1984

GENERALIZED STRATIGRAPHIC SEQUENCE

VOLK FIELD ANGB, WI

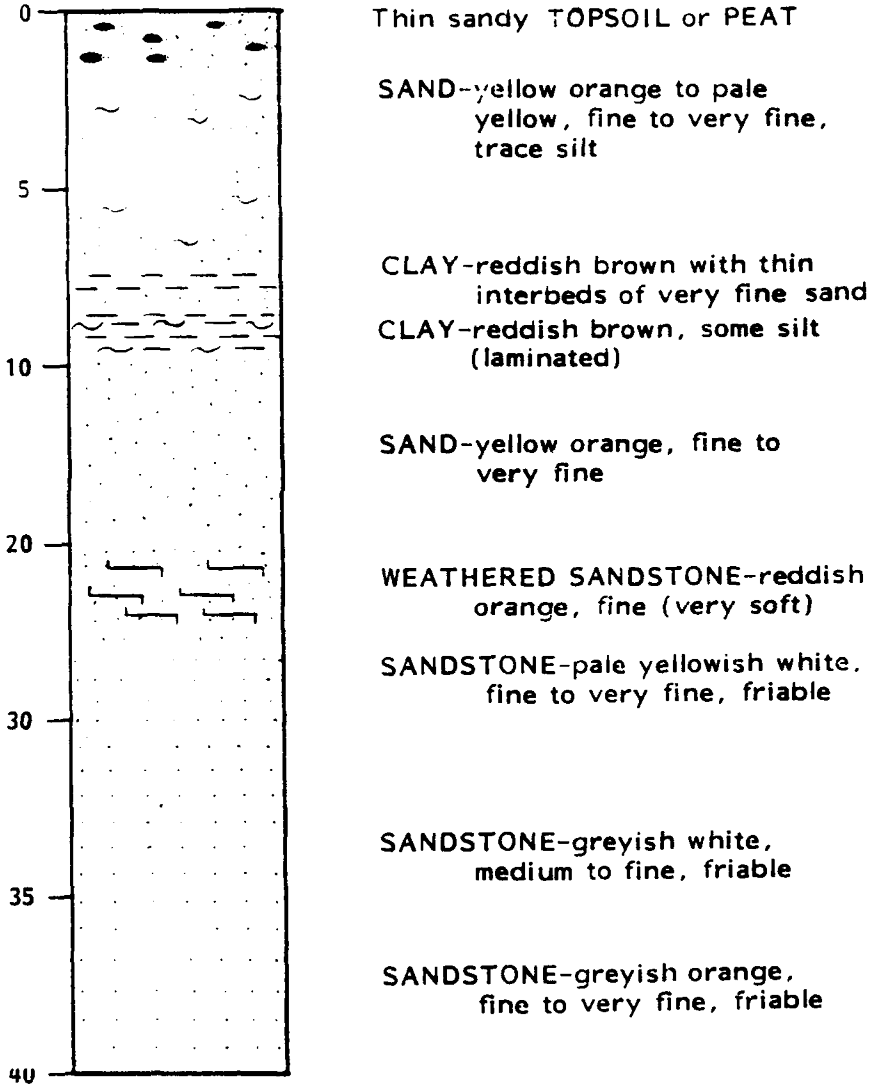
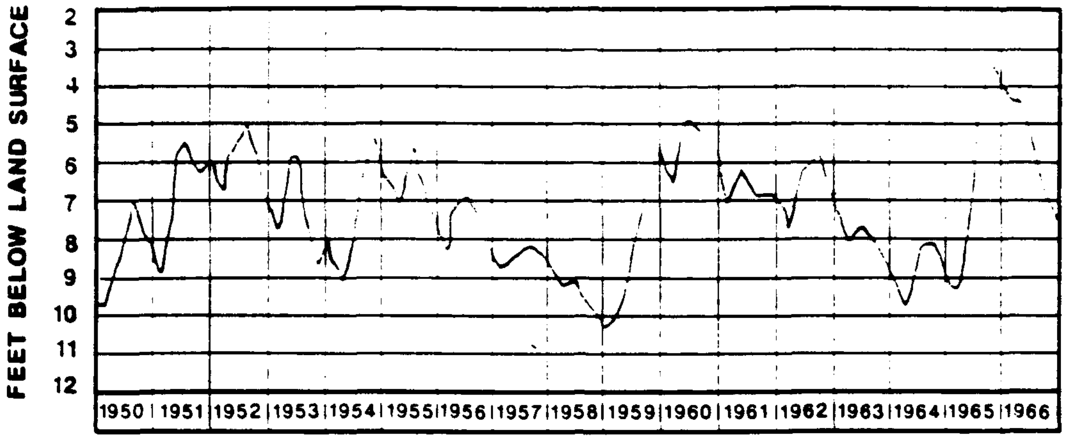


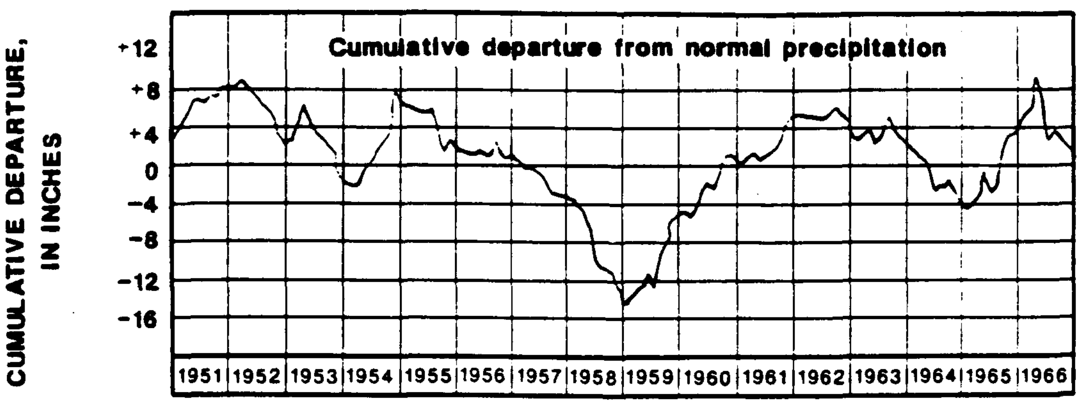
Figure 2.4

HISTORIC WATER TABLE ELEVATIONS AND MONTHLY PRECIPITATION DATA

VOLK FIELD ANGB. WI



Graph of monthly measurements of the depth to the groundwater table, observed in well W6 at Volk Field ANG Base from 1950 to 1966.

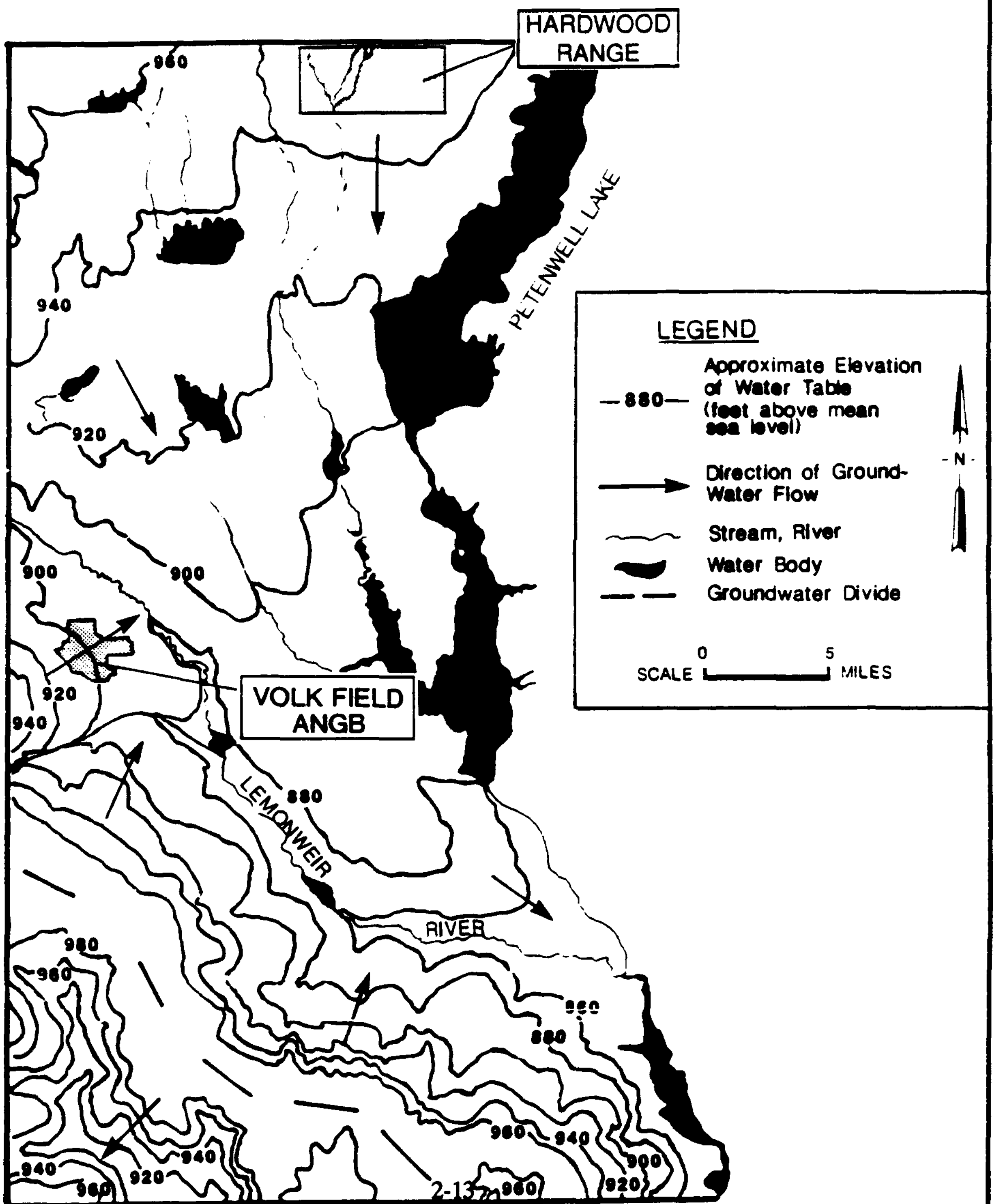


Graph of the cumulative departure from normal monthly precipitation, measured in Waushara County during the period 1952 to 1966.

SOURCE: HMTC, 1984

GENERALIZED GROUNDWATER CONTOUR MAP OF JUNEAU COUNTY FOR SEPTEMBER, 1981

VOLK FIELD ANGB, WI

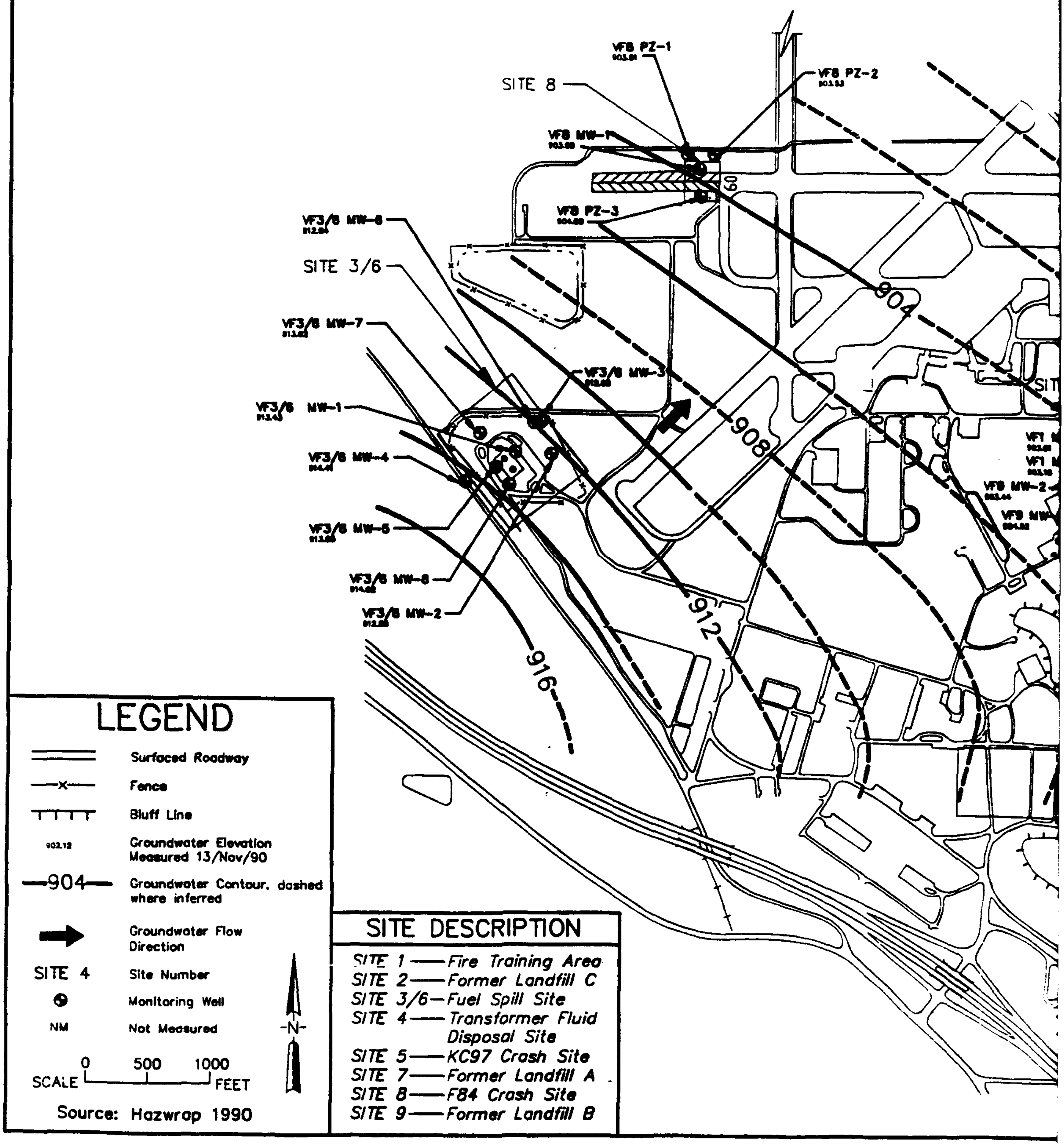


After: GSRCADA, 1981

ES ENGINEERING-SCIENCE

GROUNDWATER CONTOUR MAP F

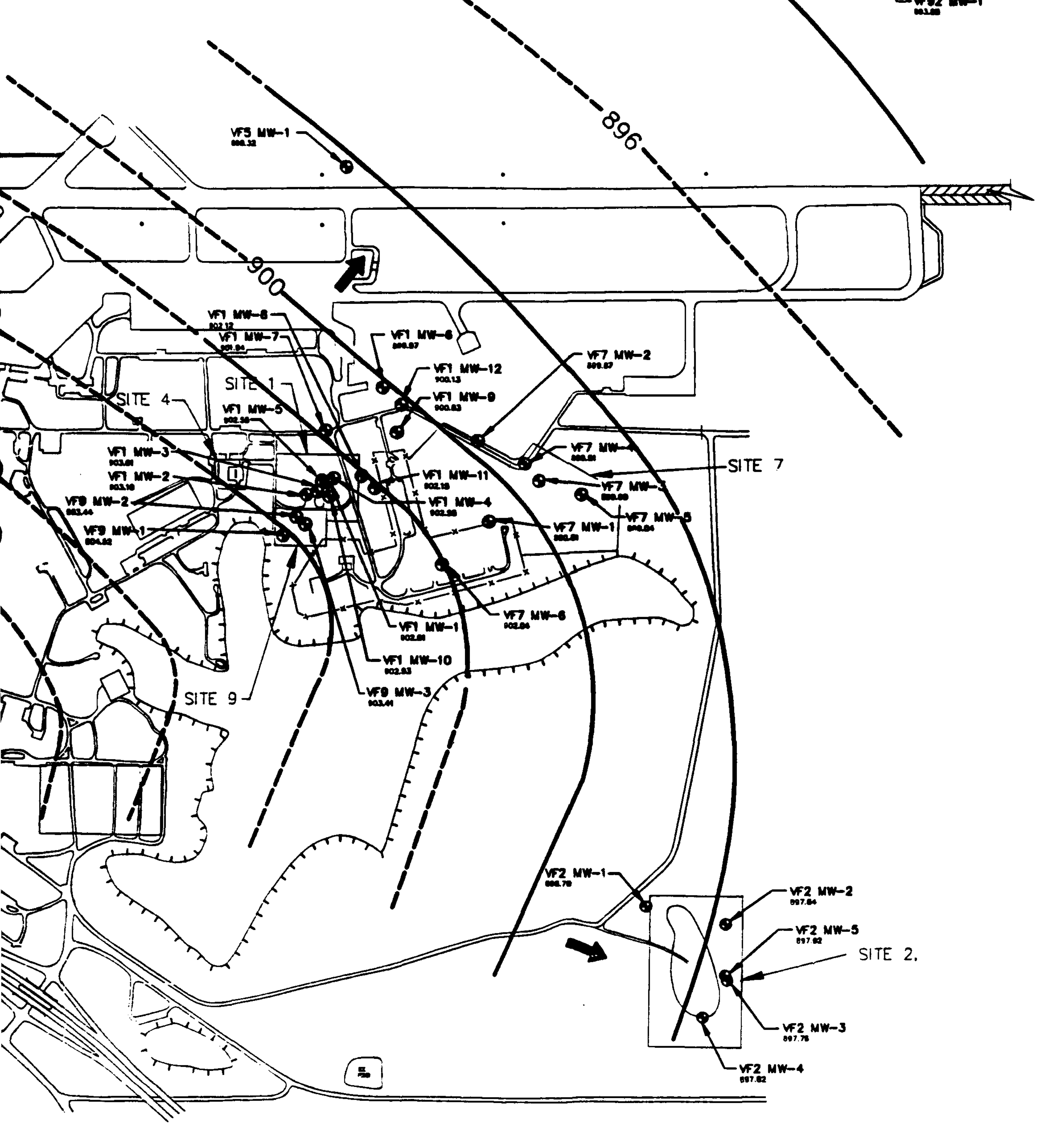
VOLK FIELD ANGB



A

Figure 2.6

R MAP FOR 13 NOVEMBER 1990
FIELD ANGB, WI



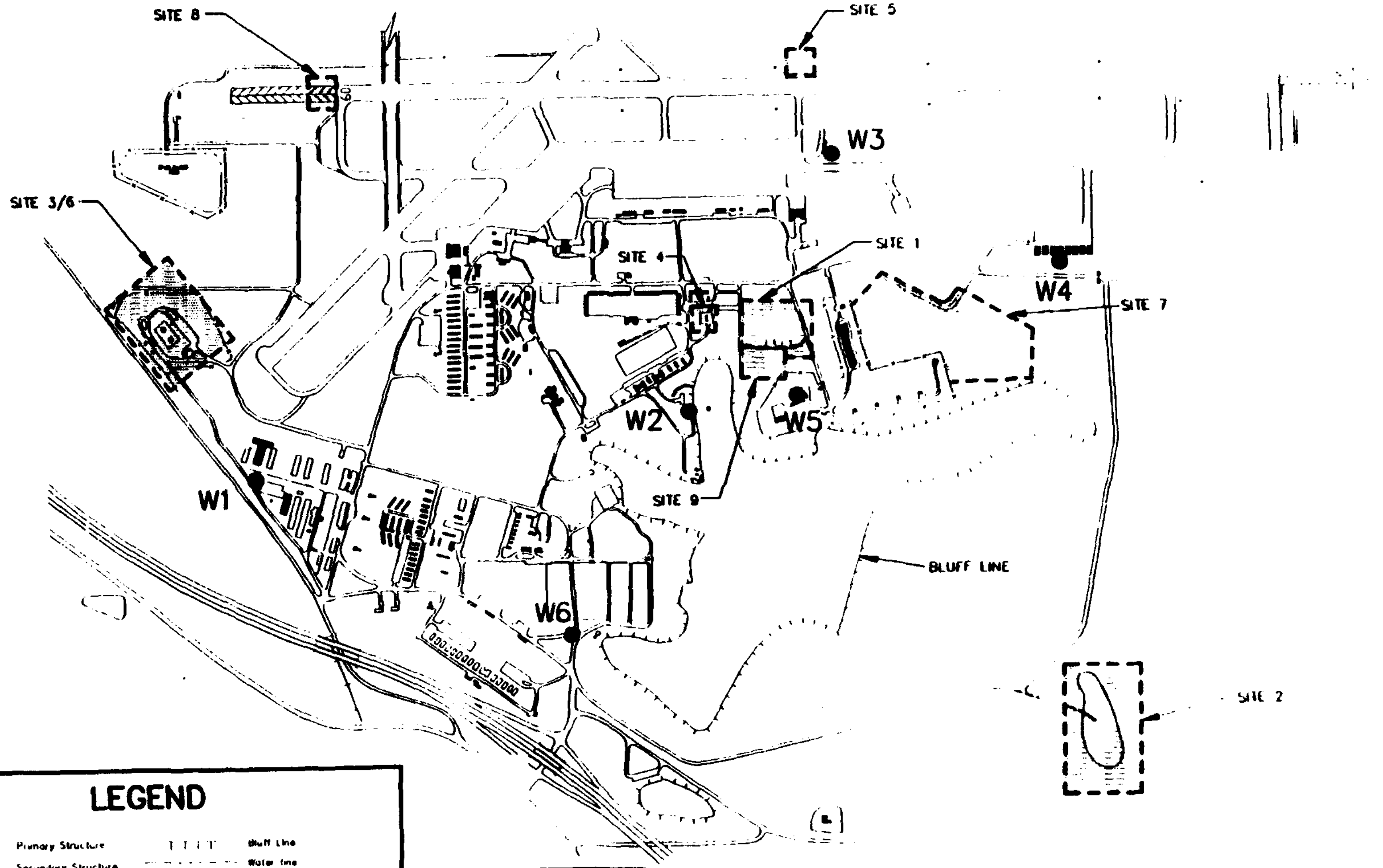
ES ENGINEERING-SCIENCE

Figure 2.7

C:\AT077\8X11WELL, 06/13/91 at 14:37

BASE PRODUCTION WELL LOCATIONS

VOLK FIELD ANGB, WI



LEGEND

Primary Structure
Secondary Structure
Surfaced Road
Unimproved Road
Runway, Taxiway & Apron
Fence
Base Production Well Location
Bluff Line
Water line
Site Location
SITE 4 Site Number
Site Location - Area encompassed is not intended to denote the presence or extent of contamination

SCALE 0 — 1500 FEET

Source: Hazwrap 1990

SITE DESCRIPTION

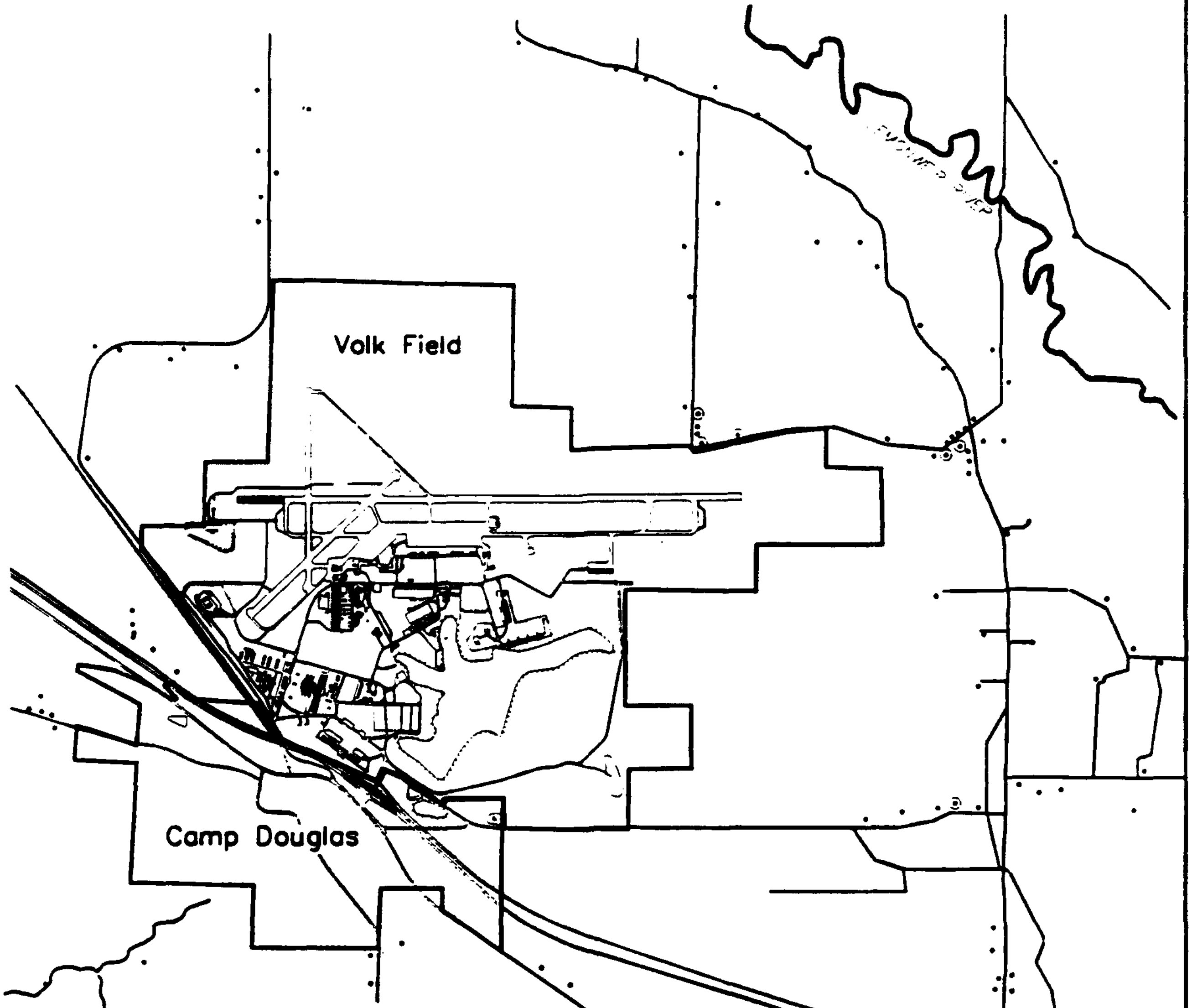
SITE 1 — Fire Training Area
SITE 2 — Former Landfill C
SITE 3/6 — Fuel Spill Site
SITE 4 — Transformer Fluid Disposal Site
SITE 5 — KC97 Crash Site
SITE 7 — Former Landfill A
SITE 8 — F84 Crash Site
SITE 9 — Former Landfill B

ES ENGINEERING-SCIENCE

Figure 2.8

APPROXIMATE LOCATION OF PRIVATE WELLS

VOLK FIELD ANGB, WI



LEGEND

— Base Boundary

• Location of residents or structures which may have associated drinking water wells.

◉ Approximate location of private wells sampled by Wisconsin DNR in 1984

Note: Location of residents in Camp Douglas are not shown for clarity.

SCALE 0 — 3500 FEET

SOURCE: Juneau County Sherriffs Department. Prepared by Lange Enterprises, 1984.

C:\CAD\AT077\BASE, 02/16/92 at 15:10

SITE 10, MUNITIONS BURIAL SITE
APPROXIMATE LOCATION OF WELLS
VOLK FIELD ANGB, WI

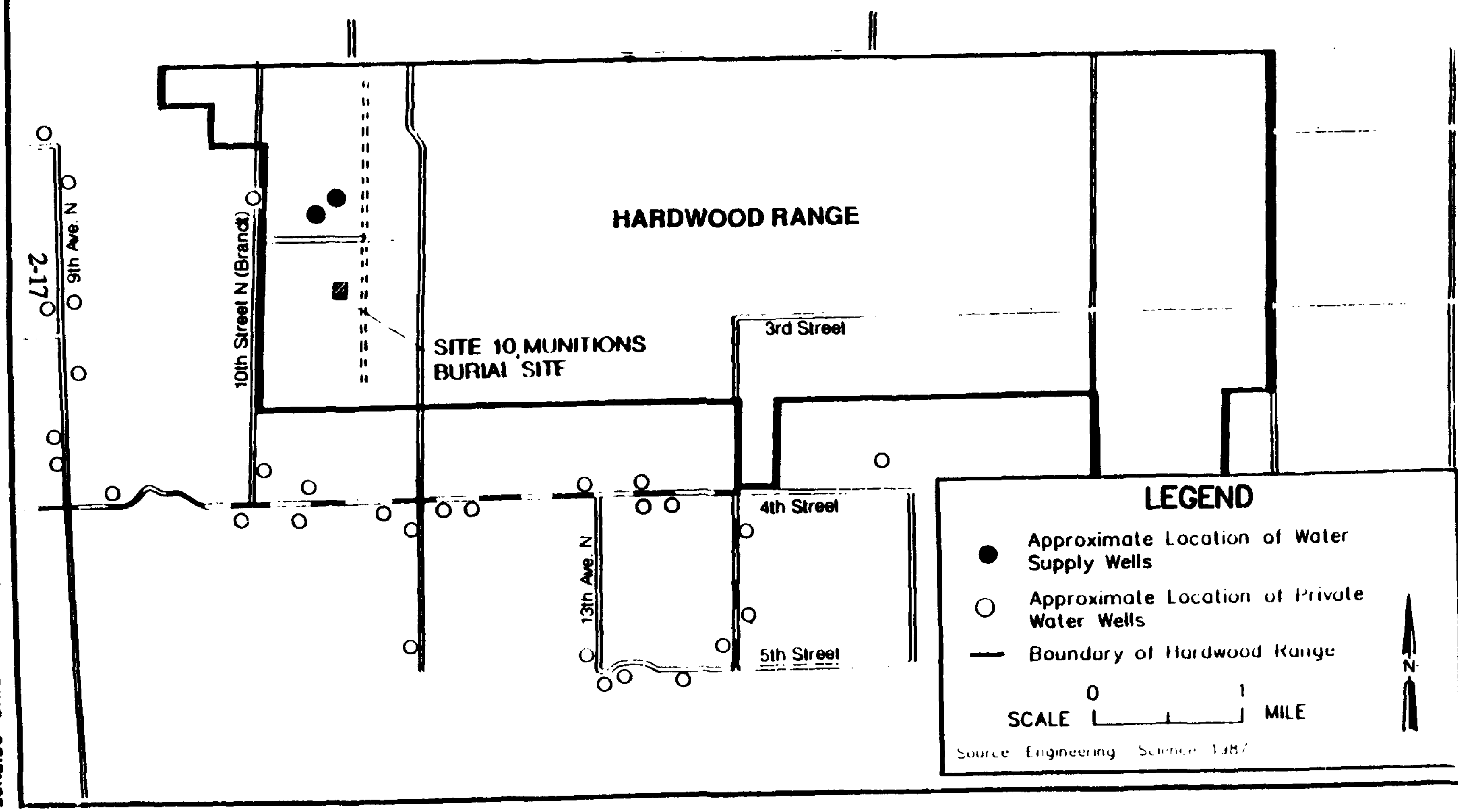
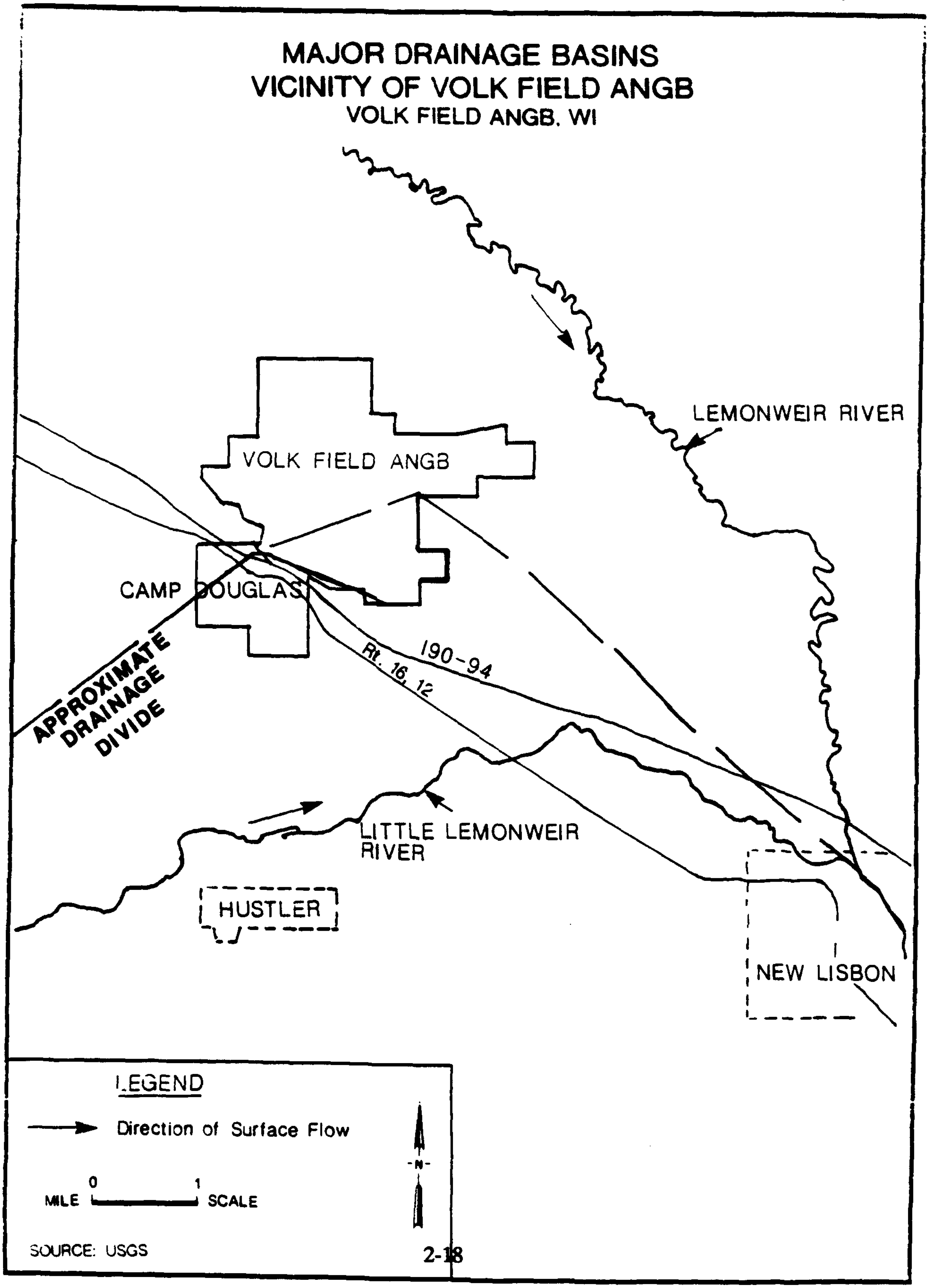


Figure 2.10



ES ENGINEERING-SCIENCE

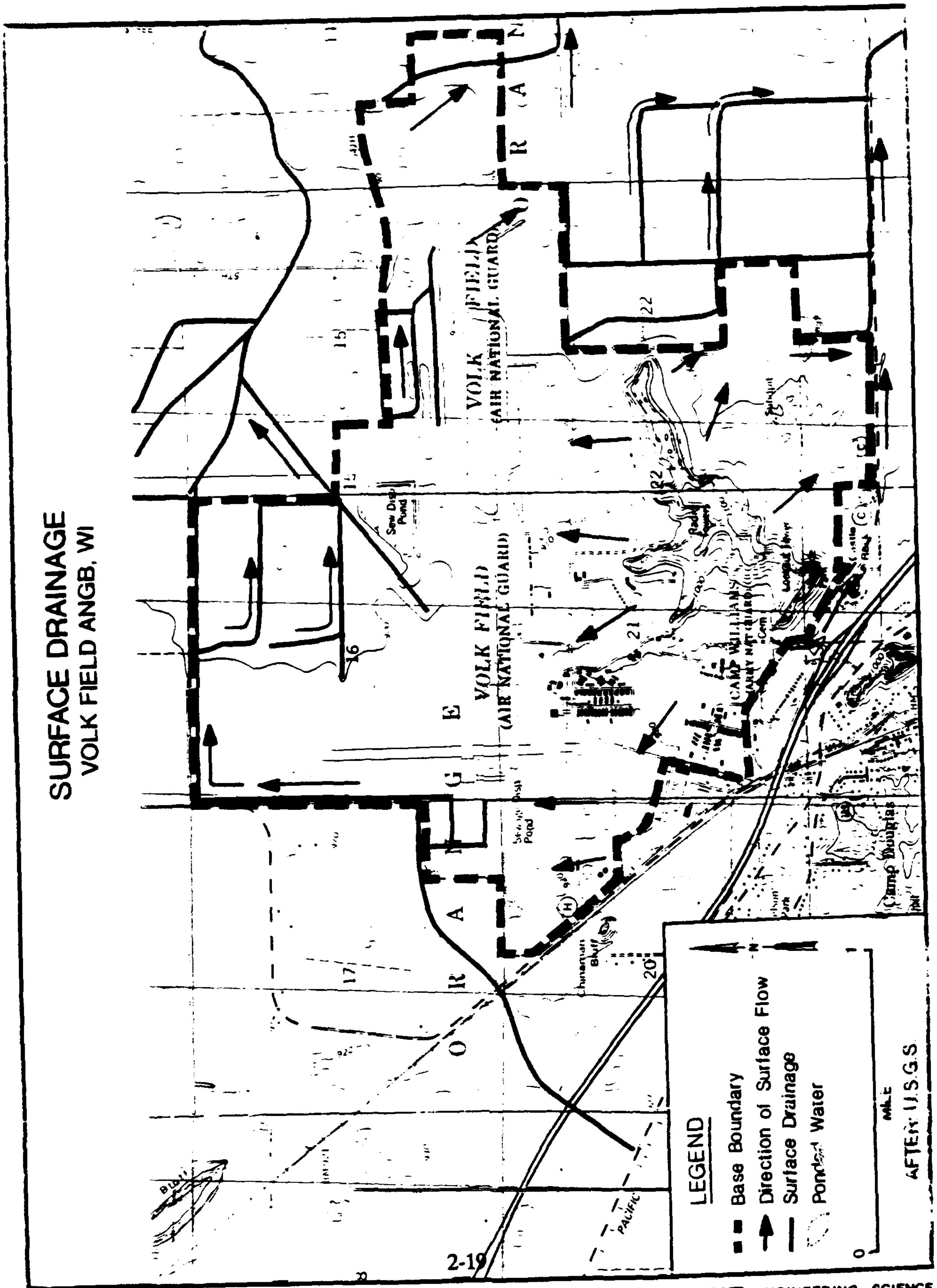
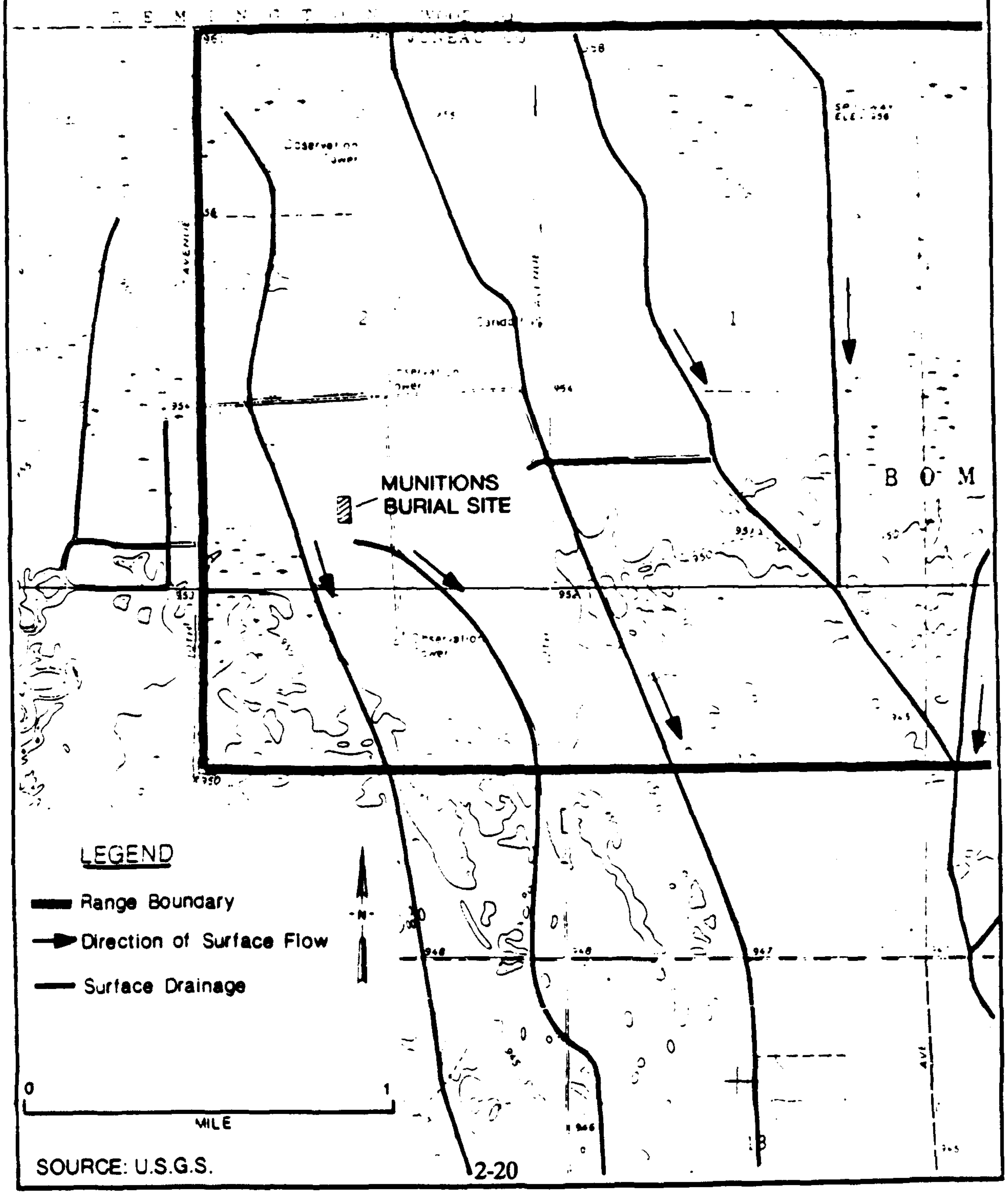

SURFACE DRAINAGE
VOLK FIELD ANGB, WI
VOLK FIELD
(AIR NATIONAL GUARD)
CAMP WILLIAMS
Sew Disp Pond
Camp Douglas
LEGEND
Base Boundary
Direction of Surface Flow
Surface Drainage
Ponded Water
MILE
AFTER U.S.G.S.

Figure 2.12

SURFACE DRAINAGE
HARDWOOD RANGE
VOLK FIELD ANGB, WI



SOURCE: U.S.G.S.

ES ENGINEERING-SCIENCE

TABLE 2.4--Continued
WELL CONSTRUCTION DETAILS
VOLK FIELD ANGB, WI

Well No.	Date Installed	Approximate Land Surface Elevation (ft)(1)	Top of Security Riser Elevation (ft)(1)	Top of Casing Elevation (ft)(1)	Borehole Depth(2) (ft)	Well Screen Interval (ft)(2)	Depth to Water from Top of Casing (ft)(3)	Water Elevation (ft)	Approximate Bedrock Depth(2) (ft)	Approximate Bedrock Elevation (ft)(6)
VF1 MW-6	10/19/89	912.5	914.56	914.73	60	47.5-57.5	14.76	899.97	6	907
VF1 MW-7	10/20/89	910.4	911.87	912.10	63	50-60	10.16	901.94	16	894
VF1 MW-8	10/25/89	910.9	912.83	913.00	64	50-60	10.88	902.12	17	894
VF1 MW-9 (4)	10/1/90	915.1	916.57	916.69	72.5	60-70	15.86	900.83	17	898
VF1 MW-10 (4)	9/27/90	915.1	916.65	916.71	43	28-38	13.78	902.93	15	900
VF1 MW-11 (4)	9/28/90	913.4	915.63	915.73	78.5	62.5-72.5	13.58	902.15	21	892
VF1 MW-12 (4)	10/9/90	916.0	917.70	917.87	72	60-70	17.74	900.13	15	901
VF1 PW1	2/13/88	917.6	919.83	919.64	37	19-34	16.19	903.45	9	909
VF2 MW-1	1/12/88	899.9	901.72	901.50	22	6-21	2.71	898.79	–	<878
VF2 MW-2	1/14/88	896.3	898.13	897.74	22	6.5-16.5	-0.10	897.84	–	<875
VF2 MW-3 (5)	1/15/88	896.7	899.13	898.75	17.5	6.5-16.5	0.99	897.76	–	<880.5
VF2 MW-4	1/18/88	896.2	898.64	898.42	17.5	6-16	0.60	897.82	–	<880
VF2 MW-5 (5)	10/24/89	897.2	899.73	899.57	65	49.5-59.5	1.65	897.92	47	850
VF 3/6 MW-1	2/12/88	920.7	922.56	922.38	24	6.5-21.5	8.95	913.43	14	907
VF 3/6 MW-2	10/20/89	921.2	923.13	923.27	23.5	6-21	10.69	912.58	7	914
VF 3/6 MW-3 (5)	10/20/89	921.5	923.18	923.44	24	6-21	11.35	912.09	13	909
VF 3/6 MW-4	10/21/89	922.6	924.64	924.77	24	6-21	10.36	914.41	7	916
VF 3/6 MW-5	10/25/89	922.0	924.13	924.17	24	6-21	10.32	913.85	18	904

3E/AT077/911J162

TABLE 2.4--Continued
WELL CONSTRUCTION DETAILS
VOLK FIELD ANGB, WI

Well No.	Date Installed	Approximate Land Surface Elevation (ft)(1)	Top of Security Riser Elevation (ft)(1)	Top of Casing Elevation (ft)(1)	Borehole Depth(2) (ft)	Well Screen Interval (ft)(2)	Depth to Water from Top of Casing (ft)(3)	Water Elevation (ft)	Approximate Bedrock Depth(2) (ft)	Approximate Bedrock Elevation (ft)(6)
VF 3/6 MW-6 (5)	10/26/89	921.2	922.74	922.96	64	50-60	10.92	912.04	11	910
VF 3/6 MW-7 (4)	10/10/90	920.5	922.26	922.40	27	8-23	8.78	913.62	15	906
VF 3/6 MW-8 (4)	10/11/90	921.2	923.19	923.38	26	8-23	9.36	914.02	12	909
VF5 MW-1	11/05/89	901.8	903.69	903.76	24.9	6-21	5.44	898.32	--	<877
VF7 MW-1	12/08/87	923.3	925.54	924.67	35	16-31	23.86	900.81	--	<888
VF7 MW-2	12/10/87	915.9	917.39	917.21	28	11.5-26.5	17.34	899.87	18	898
VF7 MW-3	12/16/87	913.7	915.59	915.30	27	8.5-23.5	15.70	899.60	--	<886
VF7 MW-4	10/21/89	912.5	914.64	914.92	34	13-28	15.41	899.51	18	894
VF7 MW-5	10/21/89	908.1	909.55	909.75	30.5	13-28	10.71	899.04	18	890
VF7 MW-6	10/24/89	935.1	936.92	937.07	43	25-40	35.03	902.04	22	913
VF8 MW-1 (4)	10/8/90	909.0	908.96	908.74	20.5	7.5 - 17.5	4.75	903.99	--	<889
VF8 PZ-1 (4)	9/30/90	907.2	907.20	906.86	14	7.5-12.5	3.25	903.61	--	
VF8 PZ-2 (4)	9/30/90	906.3	906.31	906.02	15.5	10-15	2.49	903.53	--	
VF8 PZ-3 (4)	9/30/90	908.9	908.95	908.65	13.5	7.5-12.5	3.96	904.69	--	
VF9 MW-1	12/17/87	922.7	924.55	924.27	33.5	13.5-28.5	19.75	904.52	9	914
VF9 MW-2	12/20/87	919.3	920.52	920.41	29	9-24	16.97	903.44	13	906
VF9 MW-3	12/21/87	917.1	918.87	918.55	27.5	9-24	15.14	903.41	12	905

TABLE 2.4--Continued
WELL CONSTRUCTION DETAILS
VOLK FIELD ANGB, WI

Well No.	Date Installed	Approximate Land Surface Elevation (ft)(1)	Top of Security Riser Elevation (ft)(1)	Top of Casing Elevation (ft)(1)	Borehole Depth(2) (ft)	Well Screen Interval (ft)(2)	Depth to Water from Top of Casing (ft)(3)	Water Elevation (ft)	Approximate Bedrock Depth(2) (ft)	Approximate Bedrock Elevation (ft)(6)
VF92-MW1	9/29/90	899.9	901.56	901.66	42	18-38	7.78	893.88	36	864
VF10 MW-1	1/16/88	955.8	958.15	957.82	16.5	6-16	5.28	952.54	--	< 940
VF10 MW-2	1/16/88	953.7	955.80	955.53	16.5	6.5-16.5	3.24	952.29	--	< 938
VF10 MW-3	1/16/88	955.6	957.40	957.20	16.5	6.5-16.5	5.08	952.12	--	< 940
VF10 MW-4 (5)	1/17/88	956.0	957.92	957.67	17.5	6-16	5.45	952.22	--	< 939
VF10 MW-5 (5)	10/23/89	957.0	959.09	959.06	64	50-60	9.36	949.70	--	< 893
VF10 MW-6	10/22/89	956.9	958.97	959.13	20	6-16	7.41	951.72	--	< 937
VF10 MW-7	10/22/89	954.8	956.68	956.86	20	6-16	5.24	951.62	--	< 935

(1) Surveyed on 11/29/89.
(2) Measured to ground surface.
(3) Measured on 11/14/90.
(4) Surveyed on 11/30/90.
(5) Resurveyed on 11/30/90.
(6) < indicates less than.
(7) Multiple screens.

3E/AT077/911J162

TABLE 2.5
WATER SUPPLY WELL DETAILS
VOLK FIELD ANGB, WI

Well ID	Date Installed	Supply for	Location	Drill Method	Construction	Water Yield	Lithology
Volk Field ANGB							
Well 1	1942	Main Base Supply	Bldg. 28	Rotary (?) 17-1/4"-80' 11 1/2"-303'	18" pipe, 0'-19.5' 12" pipe, 19.5'-80' Open hole 80'-303' Cement 0-80'	Water level = 16' Reported 842 gpm with "specific capacity = 30 gpm"	Sand, fine to medium, 0 to 7', Sandstone, fine to medium or fine to coarse 7'-303' (Dresbach, mainly Eau Claire and cross bedding, 190'-240'.
Well 2	–	Main Base Supply	Bldg. 319	Rotary (?)	18" Casing, 0'-shallow depth 12" casing, 0'-80' 17 1/4 Hole, 0'-80' Grout, 0'-80' 12" Open hole 80'-306'	Static = 74' Water level = 93' with 20' drawdown at 480 gpm.	–
Well 3	–	Supplemental used during summer.	25' south of Bldg. 934	–	–	–	–
Well 4	–	Supplemental used during summer.	Bldg. 950	–	–	–	–
Well 5	4/9/69	Munitions	Bldg. 916	Rotary 8 3/4" 0-80.5' 6" 80.5-282'	6" wrought iron to 80.5' open hole 80.5-282' Drill cutting backfill 0-26' Neat cement 26'-80.5'	Water level = 30.33' Water level = 32 while pumping 50 gpm for 24 hours.	Sand 0-26' Sandstone 26'-282'
Well 6	–	Not in use	290' north of Building 200 (?)	–	–	–	–
Hardwood Range							
Well 1	11/8/83	Fire Fighting	Near Center Tower	Rotary 12" 0'-75'	8" steel 0'-65' 8" stainless steel screen 0.0203 slot#, 65' to 75'	Static = 11' Water level = 52' when pumping 22.5 gpm for 4 hours.	
Well 2	11/2/83	Drinking Water	Near Center Tower	Rotary 8" 0'-66' 6" 66-70'	6" steel 0'-66' Stainless steel telescope size screen and K packer 66'-70', Bentonite and drill cutting seal from 0' to 66'.	Static = 11' Water level = 20' when pumping 16.8 gpm for 4 hours.	Sand, fine 0'-20', Sand, fine with streaks of Blue Muck (clay?), 20'-60', Sand, coarse 60'-70'

A'1077, ɔ2

TABLE 2.6
BASE PRODUCTION WELLS AND BASE BOUNDARY WELL DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990 VOLK FIELD ANGB, WI

Parameter	VF1-BPW-1	VF1-BPW-2	VF1-BPW-4	VF1-BPW-7(a)	VF92-MW1
Date Sampled	11/09/90	11/09/90	11/09/90	11/09/90	10/26/90
Halogenated Volatiles - SW8010(ug/L)					
Chloroform	U	86	U	U	U
Aromatic Volatiles - SW8020(ug/L)	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1(mg/L)	U	U	U	U	U
Semivolatile Organics - CLP SOW(ug/L)	ND	ND	ND	ND	ND
13 Priority Pollutant Metals (ug/L)					
Copper	120	U	U	269	U
Zinc	28.9	1160	U	72.2	U
Lead	25.5J4	U	U	27.9J4	U
Total Dissolved Solids - E160.1(mg/L)	37	40	230	30	150

ND - No analytes detected for this method.
U - Below the detection limit.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
(a) Duplicate for VF1-BPW-1.

SECTION 3
PROCEDURES

This section discusses the procedures and methods used during the field investigations of September-December 1989, September-December 1990 and July-November 1991. These investigations included collection of geologic and hydrogeologic data as well as soil gas, soil, surface water, groundwater and free product samples for chemical analysis at some or all of the ten sites at the Base and Hardwood Range. The data were used to determine the extent of contamination, the potential for contaminant migration, the threat to public health and the environment, and site-specific recommendations. In general, the procedures used throughout the investigation are those presented in the Work Plan for Remedial Investigation [ES, 1990d]. The Work Plan reflects procedures outlined in HAZWRAP/DOE documents 65/RI, 69/RI and 100.

The activities performed at each site were selected for completion based upon information needs and the results of previous investigations. Tables 3.1, 3.2 and 3.3 summarize the field activities conducted at each site during 1989, 1990, and 1991, respectively. The procedures used during each investigative activity are discussed by method as follows:

- geophysical surveys (magnetic and electromagnetic (EM) conductivity)
- soil gas survey
- soil boring and sampling
- sediment sampling
- monitoring well/piezometer installation and development
- groundwater sampling
- surface water sampling
- free product sampling
- chemical analyses of soil, sediment, surface water, groundwater and product samples
- land surveying of monitoring wells, piezometers, soil sampling locations and surface water stations

The geophysical surveys were conducted by ES before drilling began in 1989. Soil gas surveys were performed by ES at two sites in September and October of

1989, prior to drilling at these sites. Drilling activities, including hollow-stem auger/mud rotary soil borings and piezometer and monitoring well installation, were performed by North Star Drilling of Little Falls, Minnesota under ES supervision in October 1989 and September-October 1990. North Star personnel also helped develop the monitoring wells upon completion. Soil, surface water and groundwater samples were obtained by ES in November 1989 and in September-November 1990. Sediment and free product samples were collected in July 1991. Chemical analyses of the samples collected in 1989, 1990 and 1991 were performed by Savannah Labs, Inc. of Savannah, Georgia. Land surveying of soil borings, piezometers, monitoring wells and surface water stations was performed by Hanson Engineers, Inc. of Springfield, Illinois.

GEOPHYSICAL SURVEYS

Two types of geophysical surveys, magnetic and electromagnetic conductivity surveys, were performed at Site 1, Fire Training Area, and Site 9, Former Landfill B. These surveys were conducted to supplement previous geophysical work at these sites, to locate possible buried munitions at Site 9 prior to intrusive sampling, and to help determine placement of soil borings and soil gas sampling probes. A detailed discussion of the procedures, raw data and results related to the geophysical investigations are provided in Appendix C. A brief discussion of the procedures is presented below.

Magnetic Survey

The magnetic survey was conducted by taking magnetometer measurements at regularly spaced stations. Station locations were established using a grid system designed for the individual sites, and were laid out using a Brunton compass and measuring tape. The station locations were gridded at intervals of 25 feet. Measurements indicating the magnetic field intensity of the earth, in gammas, were obtained using a Geometrics Model G-816/826A Portable Proton Magnetometer.

Electromagnetic Survey

The EM survey measures the ability of subsurface materials to transmit electrical currents. This is a function of soil type, moisture content and groundwater depth, as well as the presence of conductive material such as metal pipes, tanks and drums. This survey was performed with a Geonics Model EM-31 Electromagnetic Terrain conductivity meter which has a depth limitation of 18 feet. The EM-31 operates by producing sinusoidally varying magnetic fields which induce currents into the ground. The induced currents are linearly proportional to the terrain conductivity. The magnitude of the conductivity is determined by measuring the magnetic field generated by the currents in the ground.. The instrument directly displays the apparent conductivity of the soil matrix [McNeill, 1980].

SOIL GAS SURVEYS

Soil gas surveys were performed at Site 1, Fire Training Area, and Site 5, KC97 Crash Site. These surveys were performed to define regions of high concentrations of organic vapors in soil; soil borings and monitoring wells would be placed in or near source areas. Areas surveyed at Site 1 included a second suspected fire training pit and a suspected munitions burn pit. The soil gas points were installed at depths ranging from 2.5 to 7.5 feet on a grid of 25-foot centers. Samples were collected through a 0.75-inch diameter hollow stainless steel sampling probe manually driven into the soil. After driving the probe to the sampling depth, a stainless-steel and Teflon® connection with sampling hose was threaded onto the top of the probe. The probe was then raised with a jack approximately 2 to 3 inches, leaving the disposable aluminum tip in the ground. The assembly was attached to a vacuum pump and purged with several volumes of soil gas. When purging was completed, the sampling assembly was connected to a Tedlar® air sampling bag placed inside a vacuum chamber. The chamber was evacuated. Once the chamber and the air surrounding the bag were evacuated, the bag would inflate due to the pressure differential which existed between the air in the sampling assembly and the vacuum chamber. When the vacuum was released, if the sample bag had not reached equilibrium with ambient pressure, the bag would collapse. Thus, this method also provided a visual method for determining if a soil gas sample had been collected in the bag.

The sample gases were withdrawn from the bags using a light gas syringe inserted through the bag septum, and the gases were injected into a Photovac 10S50 portable gas chromatograph (GC). The Photovac 10S50 was equipped with a 9-meter capillary column (Cpsil-5) and a 1-meter precolumn/backflush system. The detector was a 10.6 eV photoionization detector (PID) capable of detecting compounds at concentrations of 30 parts per billion (ppb) and higher.

The GC was calibrated according to the procedures outlined in Section 6.1 of the ES Quality Assurance Project Plan (QAPP) [ES, 1990a].

The GC output takes the form of a chromatograph which graphically displays column retention time versus detector response. Specific compounds are identified by the shape and retention time of peaks on the chromatograph. The concentration of an individual compound is determined using either the area or height of the compound's respective peak. Sample chromatographs were interpreted to determine both the total concentration of organic vapors and the concentrations of specific compounds. The results of the soil gas surveys are presented in Appendix D.

SOIL BORING AND SOIL AND SEDIMENT SAMPLING

Soil samples were collected for several reasons, including visual/lithologic classification, organic vapor scanning, and chemical analysis. Soil samples were

obtained using a split-spoon, Shelby tube, hand auger, or stainless steel trowel or spoon in unconsolidated materials. Lithologic "grab" samples were collected from mud returns with a steel shovel when drilling through bedrock. In general, soil samples were lithologically logged and screened for volatile contamination as outlined in Section 3.4.2.1 of the Work Plan [ES, 1990d]. Soil boring logs are presented in Appendix B.

Soil Samples Obtained From Hollow-Stem Auger Borings

Most of the 1989-1991 soil borings were drilled using continuous flight, hollow-stem augers. Lithologic and analytical soil samples were obtained using either a 30-inch Shelby tube or an 18-inch split-spoon sampler. Samples were collected at 5-foot intervals following Standard Penetration Test Procedures (ASTM Test D-1586). The samples were logged, screened and packaged according to the procedures outlined in subsection 3.4.2.1 of the Work Plan [ES, 1990d]. Visual observations and results of the organic vapor screening determined which samples would be submitted for chemical analysis. All downhole equipment was decontaminated according to procedures outlined in Section 3.4.6 of the Work Plan [ES, 1990d]. Samples were obtained in this manner at Sites 1, 4, 5 and 8.

The soil borings were abandoned by backfilling with a mixture of bentonite/cement grout (94 pounds of cement/5 pounds of granular bentonite/6 gallons of water). The grout was pumped into the boring through a tremie pipe. Grout was pumped from the bottom of the boring to land surface by gradually raising the tremie pipe so that it was always just below the rising grout level.

Soil Samples Obtained From Hand Augered Borings

Shallow soil borings which were required near utilities, or where use of a drill rig was deemed uneconomical, were performed with a hand auger or stainless steel trowel or spoon. Soil samples were obtained in this manner at Sites 2, 3/6, 9 and 10. The samples were logged, screened, selected for chemical analysis and packaged as described above. Exploratory hand augering completed at Site 3/6 was conducted in an identical manner; however, samples were not obtained for analysis. Additional hand augering was performed at Site 2, Former Landfill C, and at Site 7, Former Landfill A, to determine the thickness of the material covering the landfill. Borings terminated at shallow depths, occasionally less than 2 feet, were abandoned by filling the hole with bentonite pellets.

Sediment Sampling

Sediment samples were collected with a stainless steel spoon and submitted for analysis. Four sediment samples were obtained from Site 2 in 1991.

DECONTAMINATION PROCEDURES

All sampling equipment was decontaminated to prevent cross-contamination of samples. Decontamination of large equipment such as drill rigs and drill pipe consisted of the following basic steps:

- clean with high-pressure steam cleaner
- wash with potable water and non-phosphate laboratory-grade detergent
- rinse with potable water

The drill rig, drill pipe and all downhole equipment were steam cleaned prior to entering the site and decontaminated before commencing activities. Drill tools and equipment were also decontaminated after each use throughout the sampling effort. The drill rig and platform were decontaminated before entering each site or as needed as determined by the supervising geologist. Decontamination fluids were discharged into the Base sewer system.

Sampling equipment coming in direct contact with the samples received additional cleaning. This equipment included Shelby tubes, continuous core samplers, split spoons, hand trowels, beakers and bailers. A new nylon bailer line was used at each well. Sampling equipment decontamination procedures depended on the type of analyses to be preformed as outlined in Table 3.4.

MONITORING WELL INSTALLATION

Well locations were chosen based upon results obtained from previous investigations, analytical results obtained during this investigation, and observations made in the field as soil borings were drilled, including fuel odors, discoloration and organic vapor readings.

Thirty-one groundwater monitoring wells (including piezometers and temporary wells) were installed at the ten IRP sites during the 1989-1991 field investigation. Monitoring well logs are included in Appendix B. Monitoring wells and piezometers were drilled by three methods: hollow-stem augering, rotary wash drilling and hand augering.

Cuttings generated during drilling were screened with an organic vapor detector. Cuttings with suspected contamination were drummed and relinquished to the Base Civil Engineer (BCE) for disposal, while cuttings determined to be nonhazardous were spread on the soil around the site.

Monitoring Wells Installed by Rotary Wash Drilling

Most of the monitoring wells installed during the 1989-1991 field investigation were installed by the rotary wash drilling method. The wells were installed using either a 9-7/8-inch or 6-7/8-inch roller bit to drill through the unconsolidated soils and a 5-7/8-inch bit in bedrock. Wells were installed by this method at Sites 1, 2, 3/6, 5, 7, 10 and the Base boundary. These wells were all constructed of 2-inch

inside diameter (ID) Schedule 40 PVC casing and screen with threaded, flush joints. The well screens were either 10 or 15 feet in length, wire-wrapped with 0.010-inch openings, and included a threaded bottom cap and 2-foot sump. A silica sand pack was placed in the annular space around the screen, from approximately 2 feet below the bottom of the screen to at least 3 feet above the top of the screen. A minimum 2-foot thick bentonite pellet seal was placed above the sand pack. The borehole was tremie-grouted to the surface with a cement/bentonite grout.

A 6-inch diameter steel security riser with locking lid and three steel guardposts were installed around each PVC well riser. All risers were marked with well identification numbers. A diagram of a typical monitoring well construction is shown on Figure 3.1.

Monitoring Wells Installed by Hollow-Stem Auger Drilling

The monitoring well and piezometers at Site 8 were installed using 6.25-inch ID hollow-stem augers. The monitoring well was constructed as described above. The piezometers were constructed of 1-inch ID Schedule 40 PVC casing and screen. All screens were 5 feet in length with 0.010-inch openings and included a threaded bottom cap. A silica sand pack was placed in the annular space around the screen from approximately 2 feet below the bottom of the screen to about 3 feet above the top of the screen. The annular space was sealed with a minimum two-foot bentonite seal, followed by a bentonite-cement grout mixture which was tremied to the surface. The monitoring well and piezometers at Site 8 were completed with 9-5/8-inch O.D. (outside diameter) flush, locking, protective covers set in concrete.

Monitoring Wells Installed By Hand Auger

A total of three temporary monitoring wells were installed at Volk Field. Two of these wells were installed at Site 3/6 and one at Site 1. The temporary monitoring wells were installed to help define the extent of contamination. Due to the potential danger of underground utilities these wells were hand augered. The wells were constructed of 4-inch ID Schedule 40 PVC casing and screen. The screen was wire-wrapped with 0.010-inch openings and included a threaded bottom cap. The screens were 5 feet long at Site 3/6 and 10 feet long at Site 1. The wells were not sand packed or grout sealed due to their temporary nature. The wells were developed by pumping. After obtaining samples for visual or analytic purposes, each well was checked for free product and then removed. The boreholes were abandoned by backfilling with bentonite pellets.

Monitoring Well Development

Well development methods included using a small diameter, submersible, positive displacement pump, a Brainard Kilman® pump, a Keck pump and a jet pump. All monitoring wells were developed after installation.

Wells were developed by removing a minimum of 10 casing volumes. The pH, conductivity, temperature and clarity were monitored for every 10 gallons of

discharge water produced during development. The pump was initially placed at the bottom of the well and gradually moved up the well (5-10 feet at a time). The rate of raising the pump depended on the pH, conductivity, temperature and clarity of the water as well as the volume of water pumped. The well was "surged" (the process of repeatedly moving the pump up and down) in order to remove silt from the bottom of the well and to clean the screen and the sand pack. All development information was recorded on a monitoring well development record.

The discharge water was monitored for headspace readings. Discharge water was drummed if headspace readings were greater than 5 parts per million (ppm), and relinquished to the BCE for disposal.

The well was considered developed when the pH, conductivity and temperature of the water stabilized (pH ± 0.1 units, conductivity ± 10 μmho/cm, temperature ± 1°C) or when the onsite geologist determined that further development would not significantly improve the quality of groundwater.

Each pump was decontaminated prior to development by a soap wash, a potable water rinse, a methanol rinse and a distilled organic-free water rinse. An Orion Research® pH meter was used to monitor pH and temperature. The pH meter was calibrated daily with a pH 7 and pH 4 buffer solution. A Hach Company conductivity meter was used to monitor conductivity. The conductivity meter was calibrated daily with a 1413 μmho/cm potassium chloride solution. The meters were also calibrated after periods of continuous use.

Groundwater and Surface Water Sampling

Groundwater samples were collected from each site where monitoring wells were installed. Prior to sampling each well, the wells were purged of a minimum of 5 casing volumes of water using either a Teflon® bailer or a Keck pump. Groundwater samples for metal analysis were filtered through a 0.45 micron filter and then preserved with nitric acid. Otherwise, preservatives were added to sample containers prior to obtaining samples. Temperature, conductivity and pH were measured after purging and recorded in the field log book and on purging forms.

Surface water samples were collected by lowering the sample bottle below the water surface at an approximate 45° angle with the mouth of the bottle facing upstream. Preservatives were added prior to sample collection. The bottles were filled slowly to avoid turbulence and loss of preservatives. For surface water samples requiring metal analysis, two samples were collected. One sample was filtered as described for groundwater sampling and the other sample was not filtered. The numbering system used to track the samples and the handling, packaging and shipment of all groundwater and surface water samples is described in Section 4.6 of the Quality Assurance Project Plan [ES, 1990a].

Free Product Sampling

Free product sampling was conducted at Site 1 in July 1991. One bailer of free product was removed from each of the four monitoring wells containing product. The contents of each acrylic bailer were emptied into a mason jar and allowed to settle. Upon sitting, two of the mason jars contained two separate phases, the third jar contained only an organic phase and the fourth jar contained a gelatin-like emulsion which differed in appearance from the other product samples. The contents of third and fourth jars were submitted for qualitative analyses.

SAMPLE NUMBERING SYSTEM

Each sample collected for analysis was assigned a unique identification number to describe where the sample was collected. Each number consisted of a group of letters and numbers, separated by dashes and commas. Examples of the sample numbering system are presented in Table 3.5.

Field duplicates and blanks collected for quality assurance purposes were also assigned unique identifiers which were indistinguishable from sample identifiers. Imaginary site or well numbers were incorporated in field duplicate and blank identifiers.. For example, a blind duplicate of the groundwater sample VF2, MW-2, GW-1, ES would be: VF2, MW-6, GW-1, ES. Monitoring well MW-6 does not exist at Site 2. Records of the quality assurance samples were kept in the field log books.

WATER LEVEL MEASUREMENTS

The water level in each well at the Base and Hardwood Range was measured within a 12-hour period. Wells with suspected contamination were checked for free product. The water levels were measured to the nearest 0.01 foot using an electronic water level indicator referenced to the surveyor's mark made on the top of the PVC riser. The elevation of this mark was determined to the nearest 0.01 foot and referenced to an established datum. Four sets of water level measurements were made during the course of this Remedial Investigation. Tables summarizing the water level measurements and changes in water elevations are included in Appendix B. The water level elevations were used in the preparation of groundwater contour maps indicating flow direction in 1988, 1989, 1990 and 1991. These figures are also included in Appendix B.

ANALYTICAL METHODS

The groundwater, surface water, soil, sediments and product samples were analyzed for some or all of the following parameters:

- Halogenated Volatile Organics (SW8010)
- Non-Halogenated Volatile Organics (modified SW8015)
- Volatile Aromatic Hydrocarbons (SW8020)

- Polynuclear Aromatic Hydrocarbons (PAHs) (SW8100)
- Total Petroleum Hydrocarbons (TPH) (E418.1)
- Organochlorine Pesticides and Polychlorinated biphenols (PCBs) (CLP SOW)
- Base/Neutrals and Acid Extractable (Semi-Volatile Organics) (CLP SOW)
- Total Dissolved Solids (E160.1)
- Lead (SW3020/SW7421)
- 13 Priority Pollutant Metals (SW6010, SW7060, SW7740, SW7470/7471, SW7421, SW7841)
- Total Oil and Grease (SW9071)
- pH
- Temperature
- Conductivity

The target compounds and quantitation limits for all of the analytical methods are listed in Tables E.2 and E.3 of Appendix E.

Environmental Protection Agency (EPA) published methods were used as the basis for all analyses for which such methods exist. The EPA methods are contained in TEST METHODS FOR EVALUATION, SOLID WASTE, SW846; 3rd edition; or METHODS FOR THE ANALYSES OF WATER AND WASTES, EPA 600/4-79-020 (revised March, 1983). The analysis of base/neutral extractables and acid extractable semi-volatile organics were conducted in accordance with the methods listed in Contract Laboratory Protocol (CLP) Statement of Work (SOW) for ORGANIC ANALYSES (dated February 1988).

QUALITY ASSURANCE/QUALITY CONTROL

During each sampling effort with the exception of the free product sampling event, a number of quality control (QC) samples were collected and submitted for laboratory analysis. Quality control samples were not collected along with the free product samples as only qualitative, not quantitative, product analyses were conducted. The details of the QC sample collection are given in Appendix E. A list of the types of QC samples including a brief description of each sample type is outlined in the following subsections.

Trip Blanks

Trip blanks were collected for chemical analysis of volatile organics. The analytical results serve as a baseline measurement of volatile organic contamination that samples were exposed to during packaging, transport and laboratory storage prior to analysis.

The trip blanks originated in the laboratory. They were composed of High Pressure Performance Liquid Chromatography (HPLC) grade water placed in sample containers by the subcontracting laboratory, transported to the sample collection site, handled along with the samples, and returned to the laboratory along with the samples of water and/or soil collected for volatile organic analysis. The trip blank containers were not opened in the field.

One trip blank was included in each shipping parcel containing samples for volatile organics analysis. It was stored in the laboratory with the samples and analyzed by the laboratory for volatile organic compounds.

Equipment Rinseate Samples

Rinseate blanks were collected from sampling equipment used in the collection of samples when devices other than the sample bottle itself was required. The analysis of these blanks verifies cross-contamination of samples due to improperly decontaminated equipment did not occur.

Rinseate blanks were comprised of HPLC-grade water which was transported to the sample collection site, poured into the sampling device following equipment decontamination procedures, transferred to the sample bottles and shipped to the laboratory for analysis. The rinseate blanks were analyzed for the same parameters as the associated samples. Rinseate blanks were collected every other day that groundwater or surface water samples were taken.

Field Blanks

Field blanks were collected for each type of water used to decontaminate drilling and sampling equipment. One sample from each event and source of water was collected and analyzed. A separate field blank was collected for each lot of HPLC water.

Field Duplicates

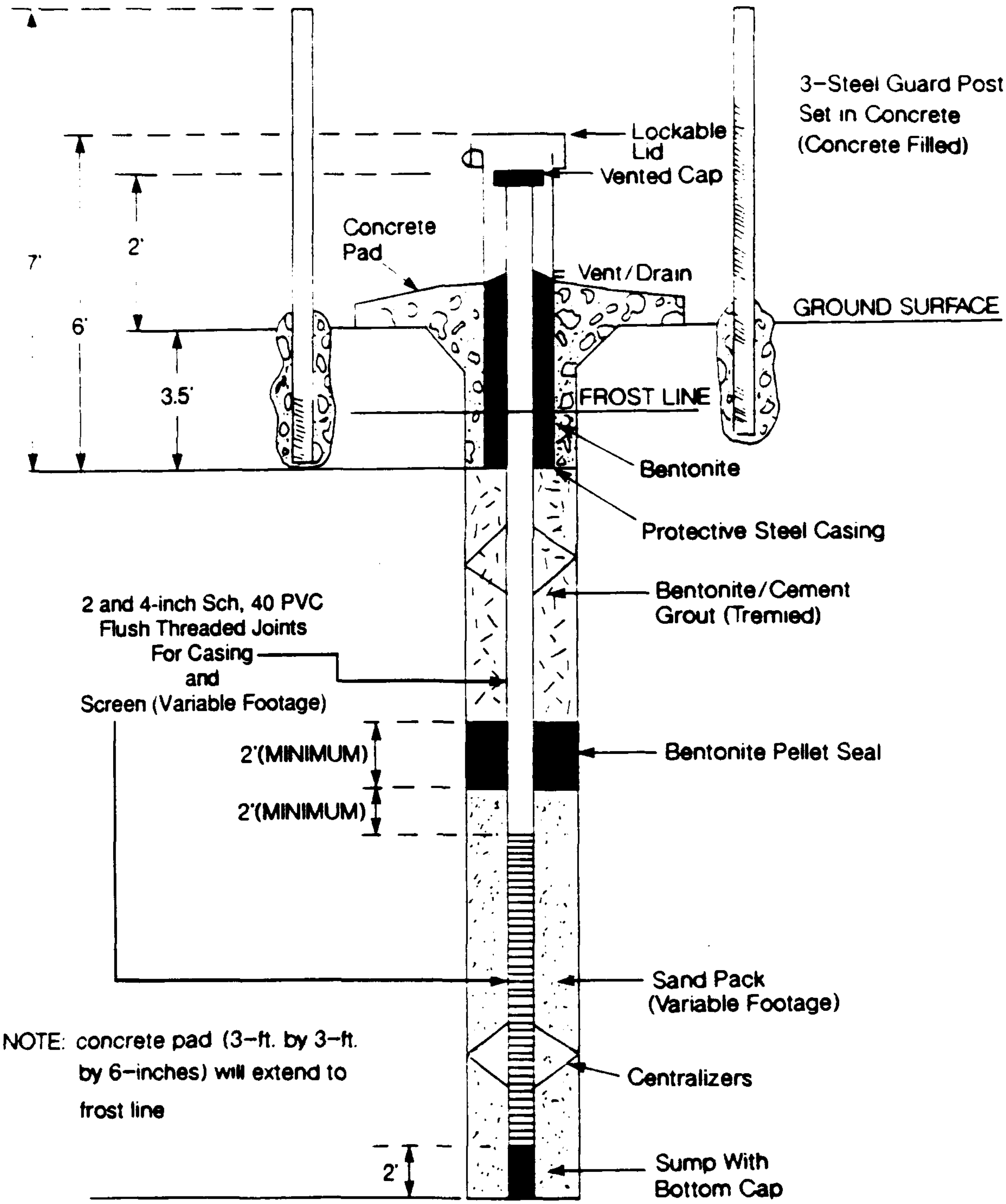
Analysis of duplicates provides statistical information relating to sample variability and serves as a check on the precision of any sample collection method as it pertains to the sampled area. Duplicate samples, with the exception of samples analyzed for volatile organics, were obtained immediately following the collection of the original sample. Duplicate and original volatile organic samples were collected simultaneously.

Ten percent of all samples from each matrix for each event were collected in duplicate and submitted for laboratory analysis. Field duplicates were labeled in such a manner so that persons performing laboratory analyses were not able to distinguish duplicates from other collected samples.

Matrix Spikes and Matrix Spikes Duplicates

Matrix spike samples and matrix spike duplicate samples were collected to assess the accuracy and precision of the analytical data. Aliquots of the same sample were prepared in the laboratory and each aliquot was treated alike throughout the analytical method. Spikes were then added at concentrations specified in the method. The percent difference between the values of the spiked duplicates provides a measure of the analytical method.

TYPICAL MONITORING WELL CONSTRUCTION DIAGRAM
VOLK FIELD ANGB, WI



NOTE: concrete pad (3-ft. by 3-ft. by 6-inches) will extend to frost line

Not To Scale

TABLE 3.1
SUMMARY OF ACTIVITIES - 1989
VOLK FIELD ANGB, WI

			Subsurface Auger Sampling (1)		Monitoring Well Installation		No. of Soil Samples (2)	Number of Water Samples (2)	
Site	Soil Gas Survey	Geophysics Surveys	No. of Boreholes	Total Linear Footage	No. Wells	Total Linear Footage		Ground	Surface
1	Yes	Yes	17	138	4	304	37	4	--
2	--	--	--	--	1	65	--	--	--
3/6	--	--	3	14	5	159.5	--	5	--
4	--	--	3	30.5	--	--	7	--	--
5	Yes	--	11	66.5	1	24.9	16	2	--
7	--	--	--	--	3	109	--	--	--
8	--	--	--	--	--	--	--	--	--
9	--	Yes	--	--	--	--	--	--	--
10	--	--	--	--	3	104	--	4	3

(1) Includes hand augered and drilled borings.
(2) Includes duplicate samples.

3E/AT077/911J162/T-3-1

TABLE 3.2
SUMMARY OF ACTIVITIES - 1990
VOLK FIELD ANGB, WI

			Subsurface Auger Sampling (1)		Monitoring Well Installation		No. of Soil Samples (2)	Number of Water Samples (2)	
Site	Soil Gas Survey	Geophysics Surveys	No. of Boreholes	Total Linear Footage	No. Wells	Total Linear Footage		Ground	Surface
1	--	--	--	--	4	266	--	27	--
2	--	--	18	35.42	--	--	5	5	5
3/6	--	--	54	321	4 (3)	72	23	12	--
4	--	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	1	--
7	--	--	12	31.25	--	--	--	7	--
8	--	--	2	12	4 (4)	63.5	4	2	--
9	--	--	3	6	--	--	3	3	--
10	--	--	3	6	--	--	3	8	--
92 (5)	--	--	--	--	1	42	--	1	--

(1) Includes hand augered and drilled borings.
(2) Includes duplicate samples.
(3) Includes two temporary wells.
(4) Includes three piezometers.
(5) ES identifiers for well along base boundary.

3E/AT[illegible]11J16[illegible]

TABLE 3.3
SUMMARY OF ACTIVITIES - 1991
VOLK FIELD ANGB, WI

			Subsurface Auger Sampling (1)		Monitoring Well Installation		No. of Sediment Samples (2)	No. of Free Product Samples (2)
Site	Soil Gas Survey	Geophysics Surveys	No. of Boreholes	Total Linear Footage	No. Wells	Total Linear Footage		
1	--	--	--	--	1 (3)	13	--	2
2	--	--	--	--	--	--	4	--
3/6	--	--	7	63	--	--	--	--
4	--	--	--	--	--	--	--	--
5	--	--	--	--	--	--	--	--
7	--	--	--	--	--	--	--	--
8	--	--	--	--	--	--	--	--
9	--	--	--	--	--	--	--	--
10	--	--	--	--	--	--	--	--
92 (4)	--	--	--	--	--	--	--	--

(1) Includes hand augered and drilled borings.
(2) Includes duplicate samples.
(3) Temporary monitoring well.
(4) ES identifiers for well along base boundary.

3E/AT077/911J162/T-3-3

TABLE 3.4
SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES[(1)]
VOLK FIELD ANGB, WI

Inorganic Sampling	Inorganic and/or Organic Sampling
Wash and scrub with detergent (laboratory grade).	Wash and scrub with detergent (laboratory grade).
Rinse with tap water.	Rinse with tap water.
Rinse with HPLC Grade water.	Rinse with methanol, follow with a hexane rinse if testing for pesticides, polychlorinated biphenyls (PCBs), or fuels.
Air dry[(2)].	Rinse with HPLC grade water.
Protect from fugitive dust or vapors by wrapping with plastic sheeting.	Air dry[(2)]. Wrap in aluminum foil.

(1) Solvents will be specified as pesticide grade or better. Paint will be removed from any part of the equipment that may contact the sample.

(2) In adverse weather conditions, air drying may not be possible. In these cases, an additional methanol rinse may be added to help dry the equipment.

AT077/91IJ162/T-3-4

TABLE 3.5
SAMPLE NUMBER SYSTEM
VOLK FIELD ANGB, WI

Project Identification:

VF (Volk Field)

Site Number:

1 (Fire Training Area)

Well Number (sequential):

MW2 - Monitoring Well Number

SB2 - Soil Boring Location

Sample Number:

GW1	Groundwater Sample Number (sequential for each sampling event)
SS1	Split-spoon Sample Number (sequential for each sampling event at a soil boring location)

Sample Destination:

SL - Savannah Laboratory

Example Sample Number:

VF1-MW2, GW-1, SL

Volk Field Air National Guard Base, Camp Douglas, Wisconsin, Site 1, Fire Training Area, Monitoring Well MW-2, the first sampling event, with sample being shipped to the Savannah Laboratory in Savannah, Georgia.

SECTION 4
CRITERIA FOR EVALUATING RESULTS

The presence of contaminants in the environment due to past materials handling or waste disposal practices does not necessarily indicate that the contaminants pose a significant (unacceptable) threat to human health or the environment. To ensure that resources for further investigation and remedial actions are efficiently committed, priorities must be established based on estimates of risk to human health and the environment. The objective of this section is to present the criteria and risk assessment procedures used to determine the significance of analytical results. A brief description of important physical and chemical properties for detected analytes is included at the end of this section.

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Detected concentrations of chemicals are compared to applicable or relevant and appropriate requirements or other criteria designed to protect human health or the environment. The attainment of ARARs must be considered in the selection of remedy. ARARs are defined as follows:

- **Applicable Requirements** are those cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at the site. Applicability implies that the remedial action or the circumstance at the site satisfy all of the jurisdictional prerequisites of a requirement.
- **Relevant and Appropriate Requirements** include those cleanup standards, standards of control and other substantive environmental protection requirements, criteria or limitations promulgated under Federal or State law that, while not "applicable" to hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a site, address problems or situation sufficiently similar to those encountered at the subject site that their use is well suited.

In addition, to-be-considered items (TBCs) are advisories or guidances issued by Federal or State government that are not legally binding and do not have the status of ARARs. To-be-considered items should be used when ARARs do not

exist for a particular chemical. In many circumstances, TBCs will be considered as part of the site risk assessment. They may also be considered when the risk assessment indicates existing ARARs are not sufficient to protect human health and the environment [U.S. EPA, August 1988].

A discussion of ARARs and TBCs pertaining to the Base are presented below for each of the environmental media on the Base that may be affected.

Surface Water

Surface water occurs at the Base and Hardwood Range mostly in low-lying swampy areas. Surface water samples were all collected from shallow pools or slow-moving, shallow creeks in these low-lying areas. These are warm waters which do not support sport fish. The State of Wisconsin surface water standards which apply to warm water forage fish, limited forage fish and limited aquatic life communities apply. Toxicity standards and human threshold criteria have been established "to protect public health and welfare, the present and prospective use of all surface waters for public and private water supplies and the propagation of fish and aquatic life and wild and domestic animal life" [NR105.01, March 1989]. Threshold concentrations for substances causing taste and odor in water have also been established to "preserve and enhance the quality of waters" [NR102.04, March 1989]. These standards are included in Table 4.1.

In addition to State criteria, Federal ambient water quality criteria may be relevant and appropriate for the protection of aquatic life and human health. They are also presented in Table 4.1. The health-based water quality criteria presented are estimates of the ambient surface water concentrations that will not result in adverse health effects in humans from the ingestion of aquatic organisms (e.g., fish). For compounds that are proven or suspected carcinogens, the recommended criteria are set at zero or no risk of developing cancer. However, since zero is not attainable either as a clean-up standard or a detection limit, these criteria are not considered ARARs. The concentrations provided for these compounds correspond to a cancer risk of 10^{-6} and only constitute to-be-considered guidance.

Other guidance for assessing contaminant levels in surface water include proposed Resource Conservation and Recovery Act (RCRA) Corrective Action Levels. These action levels are to-be-considered guidance and are listed in Table 4.1.

Groundwater

Groundwater standards do not apply to soil samples; however, compounds found in the soils could potentially migrate to the groundwater in the future.

The State of Wisconsin has established groundwater quality standards for substances which have "a reasonable probability of entering the groundwater resources of the state" [NR140.01, October 1985]. Table 4.2 presents both the established Wisconsin Department of Natural Resources Enforcement Standards

and Preventive Action Limits (PALs) for select compounds in groundwater. In general, a PAL is 10 percent of the Enforcement Standard for all substances that have carcinogenic, mutagenic or teratogenic properties. PALs for benzene and trichloroethylene are less than this percentage of the Enforcement Standard. The PAL is 20 percent of the Enforcement Standard for all other substances that are of public health concern.

The Safe Drinking Water Act (SDWA) mandates EPA establish regulations to protect human health from contaminants in drinking water. EPA has promulgated drinking water standards that generally apply to community water systems. Primary drinking water standards include Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs). MCLs are set at levels that are protective of human health, while taking into account available treatment technologies and the costs to large public water systems. MCLGs are strictly health based and do not take cost or feasibility of attainment into account. For compounds that are proven or suspected carcinogens, the MCLGs are set at zero. However, since zero is not attainable either as a cleanup standard or a detection limit, these MCLGs are not considered ARARs. Table 4.2 includes current MCLs and MCLGs. Maximum Contaminant Levels and Maximum Contaminant Level Goals that become effective in 1992 and 1993 are also included as ARARs in these tables.

Secondary drinking water regulations consist primarily of Secondary Maximum Contaminant Levels (SMCLs) for specific contaminants or water characteristics that may affect the aesthetic qualities of drinking water (i.e., color, odor, and taste). SMCLs are nonenforceable limits intended to be used as guidelines for use by states in regulating water supplies. SMCLs are given as flagged MCLs in Table 4.2.

Other criteria, advisories and guidance for assessing contaminant levels in drinking water may be used in the absence of MCLs and MCLGs; however, the EPA does not consider these criteria as ARARs. These additional criteria include proposed drinking water standards (proposed MCLs and MCLGs), drinking water health advisories and proposed RCRA Corrective Action Levels. The EPA advisory values are concentrations of contaminants in drinking water at which adverse effects would not be anticipated to occur [EPA, 1986b]. Table 4.3 includes a summary of these to-be-considered items for compounds found in groundwater at the Base.

The values for criteria presented in Tables 4.2 and 4.3 may conflict at times. In such cases, final MCLs and MCLGs, as well as state standards are always the most appropriate criteria, since they are considered ARARs. When multiple ARAR criteria exist, the most stringent criteria dominates. An exception is made with WIDNR criteria. According to the WIDNR [personal communication, 1991], PALs are incorporated as cleanup objectives during remedial action/remedial design and are not used as ARARs in the baseline risk assessment. Enforcement Standards are used in assessing risk associated with a site.

Soil/Sediment

The State of Wisconsin currently offers no established guidelines or criteria for assessing levels of contaminants in soils or sediments. The Wisconsin Department of Natural Resources (WIDNR) has used an action level of 10 mg/kg of total petroleum hydrocarbons for underground storage tank (UST) investigations [Wilbert, 1991]. A UST cleanup code for soils based on benzene, ethylbenzene, toluene and xylenes (BETX) concentrations is expected in the near future.

The Federal government proposed RCRA Corrective Action Levels for many analytes in soils in Volume 55 of the Federal Register (pages 30798-30884). The available proposed RCRA Corrective Action Levels for analytes detected in soil samples at the Base are presented in Table 4.4. In addition, the EPA has issued interim guidance on lead cleanup levels at superfund sites [EPA, 1989b]. This is also included in Table 4.4.

BASELINE RISK ASSESSMENT PROCEDURES

As part of the baseline risk assessment, a human health evaluation and an ecological evaluation were conducted for each site under investigation at the Base. The purpose of this section is to define the procedures used in conducting these baseline assessments.

The objective of a baseline risk assessment is to assess the potential risks to human health (both current and future) or the environment which may be caused by hazardous substances released from the site in the absence of any actions to control or mitigate these releases (the no-action alternative). This assessment has been conducted in accordance with the most recent EPA guidance including:

- U.S. EPA Risk Assessment Guidance for Superfund: Vol. I, Human Health Evaluation Manual (Part A) [EPA, 1989c]
- U.S. EPA Risk Assessment Guidance for Superfund: Vol. II, Environmental Evaluation Manual [EPA, 1989d]
- U.S. EPA Standard Default Exposure Factors [EPA, 1991c]
- Health Effects Assessment Summary Tables (HEAST), Annual, FY-1991 [EPA, 1991]
- U.S. EPA IRIS (Integrated Risk Information System) database [on-line, 1991a]

Human Health Evaluation

A human health evaluation consists of the following steps:

- data evaluation
- exposure assessment

- toxicity assessment
- risk characterization

The entire human health evaluation is depicted in Figure 4.1, and each of these steps are discussed in the following subsections.

Data Evaluation

The analytical data obtained during this RI were evaluated during preparation of the baseline risk assessment. In addition, the following data obtained during previous investigations were also included: soils and groundwater data from Sites 1 [ES, 1990b] and 3/6 [ES, 1990c], groundwater and surface water data from Site 2 [ES, 1990c], soils data from Site 4 [ES, 1990c] and groundwater data from Sites 7, 9 and 10 [ES, 1990c]. Metals data from unfiltered groundwater samples were not included in assessing the risks associated with groundwater [personal communication with WIDNR, 1991]. Metals data from unfiltered and filtered surface water samples were used in assessing the risks associated with surface water. The data contained in previous published documents used in the baseline risk assessment process is included in Appendix G.

Data evaluation entails the identification of chemicals of concern at a site which will be included in the risk assessment. All of the available analytical data were reviewed and validated based upon the analytical methods used, quantitation limits, data qualifiers and quality assurance/quality control (QA/QC) samples. The data validation procedures employed are explained in the QA/QC Report in Appendix E.

Compounds were included as chemicals of concern in the baseline risk assessment based on the following criteria.

Groundwater.

(1) An organic compound was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of samples analyzed; or

(b) it was detected at least once at a concentration that exceeded an ARAR;

(2) An inorganic compound was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of the filtered groundwater samples analyzed; and

(b) the concentration of the chemical detected in a filtered downgradient well sample exceeded the concentration in the upgradient (background) well by a factor of three or more [FR, Volume 55, page 51589, December 14, 1990]; or

(c) the detected concentration in a filtered sample exceeded an ARAR.

Soils.

(1) An organic compound was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of samples analyzed; or

(b) it was detected in a concentration exceeding an ARAR.

(2) An inorganic compound detected in soils was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of samples analyzed; and

(b) the detected concentration exceeded the minimum background concentration by a factor of three or more [FR, Volume 55, page 51589, December 14, 1990]; or

(c) it was detected in a concentration exceeding an ARAR.

Surface Water/Sediments.

(1) An organic compound was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of samples analyzed; or

(b) it was detected in a concentration exceeding an ARAR.

(2) An inorganic compound detected in surface water (filtered and unfiltered) or sediments was included in the risk assessment if:

(a) it was detected in 5 or more percent of the total number of samples analyzed; and

(b) the detected concentration exceeded the minimum upstream, background concentration by a factor of three or more [FR, Volume 55, page 51589, December 14, 1990]; or

(c) it was detected in a concentration exceeding an ARAR.

Frequency of Detection.

(1) Duplicate samples were included in counting the total number of samples.

(2) Background soil and sediment, upgradient groundwater and upstream surface water samples were excluded when counting the total number of samples.

Background Concentrations. Background metals concentrations in soils were evaluated using metals concentrations detected in background soil samples obtained at the Base and those found in southcentral Wisconsin [Shacklette and Boerngen, 1984]. Background soil concentrations for the Base and southcentral Wisconsin are

presented in Table 4.5. In the absence of background (soils), upgradient (groundwater) or upstream (surface water and sediments) concentrations, the practical quantitation limit (PQL) was used as the minimum background concentration. If the detected concentration of a metal exceeded 3 times (3 x's) the minimum background concentration, it was assumed that the metal was being released from the site and the metal was included in the risk assessment. The 3 x's background rule-of-thumb for detecting an observed release is taken directly from the final rule for the CERCLA, Hazard Ranking System [FR, Volume 55, page 51589, December 14, 1990]

Comparison with Blanks. If a chemical was detected in a laboratory, trip, or field blank, sample concentrations were compared to blank concentrations. For chemicals commonly identified as artifacts resulting from laboratory or field procedures (e.g., phthalate esters, acetone, etc.) the chemical was considered to be site-related (not an artifact) if the maximum concentration detected was equal to or greater than ten times the blank concentration. For other chemicals, the selection criteria used was five times the blank concentration. The comparison of blank concentrations to sample concentrations was accomplished as part of data validation, and contaminant concentrations presented in the risk assessment have previously been evaluated by this criteria.

Exposure Assessment

Exposure assessment is conducted to identify pathways whereby human receptors may be exposed and to estimate the frequency, duration and magnitude of such exposures. Exposure assessment is a multi-stage process which involves characterization of the exposure setting, identification of complete pathways of exposure and quantification of exposure. These process steps or stages are discussed and described below.

Exposure Setting. A detailed description of the environmental setting, maps, drinking water well locations and details of the field investigations conducted for each of the sites at the Base can be found in the Environmental Setting (Section 2) and Procedures (Section 3) sections of this report.

Exposure Pathways. Pathways of exposure are identified after a review of information on transport media, release sources, chemical-specific environmental fate and transport, exposure points, routes of exposure and potentially exposed populations. A pathway is considered to be complete if 1) there is a source or chemical release from a source; 2) there is an exposure point where human contact can occur; and 3) there is a route of exposure (oral, dermal, inhalation) through which the chemical can be taken into the body. Under current EPA guidance, it is necessary to consider both current and hypothetical (future) pathways.

Exposure Point Concentrations. Exposure point concentrations represent the concentration of a given chemical at the location where human exposure occurs.

These values can be calculated on the basis of existing analytical data, or through the use of predictive modeling. Exposure point concentrations in this assessment are based on the available analytical data for both current and future exposure scenarios involving soils, groundwater and surface water. The future exposure scenarios consider receptors (humans) who may live on or work at the site or immediately downgradient or downstream of the site, as appropriate.

Exposure point concentrations for groundwater, surface water and soils are used in the calculation of human intakes (doses) for oral and dermal exposures. Oral and dermal intakes are subsequently used along with oral reference toxicity information to calculate risks for these pathways of exposure. Throughout this risk assessment a conservative approach to exposure point concentrations was taken. This approach results in most exposures being "hypothetical". For example, most exposures assessed are based on hypothetical (future) homesteaders/residents or workers being exposed, and it should be clearly understood that these exposure conditions do not currently exist and may not be realistically expected in the future.

- **Reasonable Maximum Exposures (RMEs)**

EPA places emphasis on determining reasonable maximum exposures (RMEs) and recommends using the 95 percent UCL on the arithmetic mean in the estimation of these RMEs. Therefore, in this assessment the 95 percent UCL for the arithmetic mean (average) is used as the exposure point concentration for each chemical at each exposure point.

The 95 percent UCL for each compound was calculated as follows:

UCL = Mean + $t_{.95}$ (S/Square root of n)

Where: Mean = Arithmetic Mean

$t_{.95}$ = Value of t from Student's t-distribution with n-1 degrees of freedom (alpha = 0.025 in each tail).

S = Standard Deviation

n = Number of samples taken

The arithmetic mean concentration of each compound was determined by averaging the detected concentrations and one-half of the practical quantitation limit (PQL) for all samples in which the compound was not detected. Practical quantitation limits used in 1989 and 1990 are included in Tables E.2 and E.3 in Appendix E of this document. The 1987/1988 PQLs are included in Appendix G. In cases where the total number of samples was less than five, the maximum detected concentration was used in place of the 95 percent UCL for the arithmetic mean (average).

It should be noted that sampling was not conducted on a random basis. The sampling at the Base was intended to identify "hot spots" and to define the extent of contamination. Data gathered from "hot" areas are averaged with data from the periphery of a site. Thus, the 95 percent UCLs are conservatively representative of the site concentrations.

- **Showering Exposures**

Exposure point concentrations for volatile organic compounds (VOCs) released from groundwater during showering were modeled on the basis of work conducted by Andelman [1984, 1985a and 1985b]. In the model, the air concentration is determined by a balance between the rate of release from the shower water and the rate of air exchange between the shower and the rest of the house. The constants occurring in the model have been set to match the observed efficiency of volatilization of trichloroethene (TCE) in model showers, and to fit the observed shower air concentrations of TCE in several homes with contaminated water where measurements have been made. Scaling to other contaminants is accomplished by assuming that the rate of volatilization between shower water and the air is proportional to the Henry's Law Constant. The average concentration of a volatile compound in the shower air over a period of t_s minutes is:

$$C_s = C_{inf}[1 + (1/kt_s)(\exp(-kt_s)-1)]$$
for $t_s > 0$

C_s = average concentration of a volatile compound in the shower air over a duration of t_s minutes (mg/m^3). Note: Can be converted to $\mu g/m^3$ by multiplying by 1,000.

t_s = time in shower, typical value for an adult is 12 minutes (min)

k = rate constant for exponential function, defined below (1/min)

$k = F_a/V_b$

F_a = flow rate of air in shower, typical value is 2.4 m^3/min (m^3/min)

V_b = volume of bathroom, typical value is 12 m^3 (m^3)

C_{inf} = asymptotic concentration in air if shower ran for a long time (much longer than five minutes), calculated below (mg/m^3)

$C_{inf} = [(E)(F_w)(C_t)]/F_a$

C_t = concentration in shower water determined by case; C_t is the concentration of contaminant in groundwater where domestic water is provided by a well (mg/L or ppm); 95th percent UCL detected concentrations were used in this calculation.

E = efficiency of release of compounds from water to air (unitless)

E = $(E_{TCE})(H)/(H_{TCE})$

F_w = flow rate of water in shower, typical value is 8 L/min (L/min)

E_{TCE} = efficiency of release of TCE from water to air, typical value is 0.6 (unitless)

H = Henry's Law Constant for an organic compound (m^3-atm/mol)

H_{TCE} = Henry's Law Constant for TCE, typical value is H_{TCE} = 9.10E-03 (m^3-atm/mol)

Exposure point concentrations for air are used directly along with inhalation reference toxicity information to calculate risks associated with inhalation pathways. For example, if exposure to a carcinogen occurs for a portion of the lifespan, the exposure concentration was averaged over a lifespan of 70 years. This is consistent with the procedures outlined below for calculating human intakes for oral and dermal exposures to carcinogens.

Human Intakes. Human intakes over a long-term period of exposure, called chronic daily intakes (CDIs), are calculated for each chemical, receptor and pathway associated with oral or dermal exposure. CDIs are expressed in terms of mg/kg/day and are calculated from the exposure point concentration for each chemical and variables which account for contact rates, exposure frequency, exposure duration, body weights, absorption factors and whether or not the chemical of concern is a carcinogen or non-carcinogen. The variables used in the calculation of CDI were those recommended in EPA guidance [EPA, 1989c] and Hawley [1985].

CDIs for chemicals which are associated with carcinogenic effects are calculated differently from those associated with noncarcinogenic effects. For carcinogens, intake is averaged over the average lifespan of a person (70 years). This is to account for the fact that cancer is considered by EPA to be a non-threshold phenomenon and the risk of developing cancer is accrued over a lifetime of exposure. For non-carcinogens, CDI is averaged over the period of exposure rather than over a lifetime. This approach reflects the fact that noncarcinogenic effects have a threshold of toxicity, which, if exceeded for a chronic period of time (7 years for a human), might result in the development of adverse health effects. It should be noted the terms "threshold" and "non-threshold" refer to toxicity rather than dose. Toxicity is a function of dose, as well as duration and frequency of exposure. Therefore, exposure duration must be appropriate to the type of toxic phenomenon being assessed, i.e., carcinogenic verses noncarcinogenic endpoints.

• **Soils/Sediments**

The oral CDIs for a receptor exposed to a contaminant in soils or sediments were calculated as follows:

$$\text{Intake} = \frac{CS \times IR \times ABS \times CF \times EF \times ED}{BW \times AT}$$

Where: CS = Concentration in Soils (mg/kg)

IR = Ingestion Rate (mg soil/day)

ABS = Absorption Factor (decimal fraction corresponding to efficiency of absorption)

CF = Conversion Factor (10^{-6} kg/mg)

ED = Exposure Duration (years)

EF = Exposure Frequency (days/year)

BW = Body Weight (kg)

AT = Averaging Time (time over which exposure is averaged in days)

Values for these variables along with the rationale for their selection and a reference for the selected value are given in Table 4.6. All compounds detected in soils were considered to be absorbed through the gastrointestinal (GI) tract. The CDIs for carcinogenic and noncarcinogenic effects were not adjusted for GI absorption (ABS = 1) since the RfDs (reference doses) and slope factors which are used to calculate hazard indices and risk are not adjusted for GI absorption. None of the oral CDIs for carcinogenic effects were adjusted for absorption since the associated slope factors used to calculate risk were not adjusted for absorption.

• **Dermal Absorption (Soils)**

Dermal CDIs for each receptor and compound in soils were calculated as follows:

$$\text{Intake} = \frac{CS \times SA \times AF \times ABS \times CF \times EF \times ED}{BW \times AT}$$

Where: CS = Concentration in Soils (mg/kg)

SA = Skin Surface Area contacted per event (cm^2/event)

AF = Soil-to-Skin Adherence Factor (mg/cm^2)

ABS = Absorption Factor

CF = Conversion Factor (10^{-6} kg/mg)

ED = Exposure Duration (years)

EF = Exposure Frequency (events/year)

BW = Body Weight (kg)

AT = Averaging Time (time over which exposure is averaged--days)

Values for these variables along with the rationale for their selection and a reference for the selected value are given in Table 4.6. Since dermal absorption of metals is generally recognized as negligible, only organic compounds were considered to be absorbed dermal. For polycyclic aromatic hydrocarbons (PAHs) an ABS of 0.03 was used. This is based on experimental evidence that 3 percent of an applied dose of benzo(a)pyrene is absorbed across human skin [ATSDR, 1988]. For the remainder of the organic compounds, an ABS of 0.15 was used. This value was presented by Hawley [1985] to account for the matrix effect of soil on dermal absorption. Dermal intakes were adjusted for absorption since the oral reference toxicity values used in the calculation of dermal risk are assumed to reflect 100 percent oral absorption.

- **Groundwater**

The oral CDI for a receptor and compound in groundwater was calculated as follows:

$$\textbf{Intake} = \frac{\textbf{CW} \times \textbf{IR} \times \textbf{EF} \times \textbf{ED}}{\textbf{BW} \times \textbf{AT}}$$

Where: CW = Concentration in Groundwater (mg/L)

IR = Ingestion Rate (L/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (period over which exposure is averaged--days)

Values for these variables along with the rationale for their selection and a reference for the selected value are given in Table 4.7. All compounds detected in groundwater were considered to be absorbed through the GI tract. The CDIs for noncarcinogenic effects were not adjusted for gastrointestinal GI absorption since none of the RfDs which are used to calculate hazard indices are adjusted for GI absorption. None of the oral CDIs for carcinogenic effects were adjusted for absorption since the associated slope factors used to calculate risk were adjusted for absorption.

- **Dermal Absorption (Groundwater)**

Dermal CDIs for each chemical in groundwater and receptor were calculated as follows:

$$\textbf{Intake} = \frac{\textbf{CW x SA x PC x ET X EF x ED x CF}}{\textbf{BW x AT}}$$

Where: CW = Concentration in Groundwater (mg/L)

SA = Skin Surface Area Contacted (cm^2)

PC = Chemical-specific Dermal Permeability Constant (cm/hr)

ET = Exposure Time (hr/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

CF = Conversion Factor (1 liter/1000 cm^3)

BW = Body Weight (kg)

AT = Averaging Time (period over which exposure is averaged--days)

Values for these variables along with the rationale for their selection and a reference for the selected value are given in Table 4.7. Dermal absorption was considered to occur for adults during showering and for children during bathing.

Workers were not considered to be exposed dermal since their showers would be taken at home. Handwashing at work would be expected to contribute little to overall exposure in comparison with other exposure pathways. Since dermal absorption of metals is generally recognized as negligible, only organic compounds were considered to be absorbed dermal. Since the oral reference toxicity values used to estimate risk associated with dermal exposure are assumed to reflect 100 percent oral absorption, the CDIs for dermal absorption of groundwater were also adjusted to reflect dermal absorption. Since permeability constants are not available for these compounds, the permeability constant of water was used to adjust intake for absorption per EPA guidance [EPA, 1989c].

- **Surface Water**

The oral CDI for a receptor and compound in surface water was calculated as follows:

$$\textbf{Intake} = \frac{C_{sw} \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where: C_{sw} = Concentration in surface water (mg/L)

IR = Ingestion Rate (Liters/hour)

ET = Exposure Time (hrs/day)

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

AT = Averaging Time (period over which exposure is averaged -- days)

Values for these variables along with the rationale for their selection and a reference for the selected value are given in Table 4.7. The exposure scenario used to assess exposure to surface water is very conservative and assumes that on-site recreational exposure to surface water contaminants will occur through incidental ingestion. These exposures were assumed to occur for both adults and children.

Toxicity Assessment

Toxicity assessment is a two-step process whereby the potential hazards associated with route-specific exposure to a given chemical are 1) identified by reviewing relevant human and animal studies; and 2) quantified through analysis of dose-response relationships. The EPA has conducted numerous toxicity assessments which have undergone extensive review within the scientific community. EPA toxicity assessments and the resultant toxicity values will be used in the

baseline evaluation to evaluate both carcinogenic and noncarcinogenic risks associated with each chemical of concern and route of exposure.

EPA toxicity values which are used in this assessment include:

- chronic reference doses (RfD: noncarcinogenic effects, oral exposure);
- chronic reference concentrations (RfC: noncarcinogenic effects, inhalation exposure);
- carcinogenic slope factors (carcinogenic effects, oral exposure); and
- carcinogenic unit risk factors (carcinogenic effects, inhalation exposure).

RfDs and RfCs. The chronic RfD or RfC for a compound is ideally based on studies where either animal or human populations were exposed to a given compound by a given route of exposure for the major portion of the lifespan (referred to as a chronic study). RfDs are reported as doses in milligrams of chemical per kilogram body weight per day (mg/kg/day). RfCs are reported as concentrations in milligram of chemical per cubic meter of air (mg/m^3).

RfDs and RfCs represent thresholds for toxicity. They are derived such that human lifetime exposure to a given chemical via a given route at a dose at or below the RfD or RfC should not result in adverse health effects, even for the most sensitive members of the population.

Carcinogenic Slope and Unit Risk Factors. Carcinogenic slope factors and unit risk factors are route-specific values derived only for compounds which have been shown to cause an increased incidence of tumors in either human or animal studies. Slope factors and unit risk factors are 95 percent UCLs on lifetime risk and are determined by low-dose extrapolation from human or animal studies. When an animal study is used, the final slope factor or unit risk factor has been adjusted to account for extrapolation of animal data to humans. Slope factors are reported as risk per dose $(mg/kg/day)^{-1}$. Unit risk factors are reported in units of risk per concentration $(\mu g/m^3)^{-1}$.

Sources of Toxicity Values

The available EPA RfDs and RfCs used in this assessment are presented in Table 4.8 along with other relevant toxicity information. Table 4.9 provides the unit risks and carcinogenic slope factors used. These values were obtained from EPA's IRIS database and EPA's Annual HEAST [EPA Health Effects Assessment Summary Table, Annual FY-1991, January 1991]. Toxicity profiles for each of the chemicals of concern are presented in Appendix F.

Dermal Exposures. It should be noted that EPA has not derived toxicity values for all routes of exposure. Most of the available toxicity values are for oral or inhalation exposures. However, values are not currently available for most dermal exposures, because scientific studies have not been conducted to quantify dermal

toxicity and carcinogenic potential for a vast majority of the priority pollutants. Until recently scientists have assumed that dermal exposures were minimal in comparison with oral exposure.

Given the lack of information on absorption, and the lack of well defined exposure models, the scientific community has not reached a consensus as to the contribution of dermal absorption to total exposure. EPA has suggested [EPA, 1989c] that an oral reference toxicity value (RfD or slope factor) be modified to reflect dermal absorption. However, the toxic end points for oral and dermal absorption (for a compound) are either unknown or different and oral and dermal absorption estimates have generally not been made. As a consequence, any assessment of the contribution of dermal exposure to overall risk needs to be viewed as highly tentative.

Dermal exposures to groundwater and soils were estimated in this assessment. Dermal exposures and risks were calculated only for organic compounds as it is generally recognized that many inorganic compounds, including metals, are not well absorbed across the skin. The carcinogenic PAHs (benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3,-c,d) pyrene, chrysene and dibenzo(a,h)anthracene) are known to cause effects at the site of application; oral reference toxicity values were not used to assess risks associated with dermal exposure to these compounds. Oral toxicity values for other compounds were used in unmodified form as estimates of dermal toxicity. In doing so, one assumes 100 percent oral absorption.

Risk Characterization

In the final step of the baseline health evaluation, CDIs for each pathway of exposure are integrated with EPA reference toxicity values to characterize risk. Carcinogenic and noncarcinogenic effects are characterized separately. Toxicity values and critical effects are listed for the detected analytes in Table 4.8 (noncarcinogenic) and 4.9 (carcinogenic).

Noncarcinogenic Effects. To characterize the overall potential for noncarcinogenic effects associated with exposure to multiple chemicals, EPA has developed a hazard index (HI) approach. This approach assumes that simultaneous sub-threshold chronic exposures to multiple chemicals are additive and could result in an adverse health effect. The HI is calculated as follows:

$$\mathbf{HI = E_1/RF_1 + E_2/RF_2 + ...E_i/RF_i}$$

Where: E_i = Exposure intake (CDI) or concentration for the ith toxicant

RF_i = RfD (oral) or RfC (inhalation) for the ith toxicant

The term E/RF is referred to as the hazard quotient.

It is noted for this assessment, exposure intake is "chronic" exposure. Chronic exposure is defined as exposure which occurs over the majority of a lifespan. For a human, chronic exposure is considered to include exposures of at least seven years duration.

Calculation of an HI greater than 1 in indicates the potential for adverse health effects. Indices greater than one will be generated when the intake (oral exposure) or air concentration (inhalation exposure) for a chemical of concern exceeds its RfD or RfC. However, given a sufficient number of chemicals under consideration, it is also possible to generate an HI greater than one even if none of the individual chemical intakes or concentrations exceed their respective RfDs or RfCs. In this assessment, HIs were generated for each pathway of exposure at Sites 1, 2, 3/6, 5, 7, 9 and 10.

Carcinogenic Effects. Carcinogenic risk is expressed as a probability of developing cancer as a result of lifetime exposure. For a given chemical and route of exposure, carcinogenic risk is calculated as follows:

Oral Risk = Exposure Intake x Slope Factor

Inhalation Risk = Exposure Concentration x Unit Risk Factor

For exposures to multiple carcinogens, EPA assumes the risk associated with multiple exposures is equivalent to the sum of their individual risks.

EPA's acceptable target range for carcinogenic risk associated with Superfund sites is one-in-ten-thousand (10^{-4}) to one-in-one-million (10^{-6}).

In this assessment, carcinogenic risk has been calculated for each pathway of exposure at Sites 1, 2, 3/6, 5, 7, 9 and 10.

Uncertainty

There are several sources of uncertainty in the risk calculations. These include uncertainties associated with:

- exposure scenarios;
- exposure point concentrations; and
- reference toxicity values.

The exposure scenarios used in this assessment are "standard" scenarios commonly used in baseline Superfund risk assessments. Although the scenarios used here were tailored as much as possible to the existing site-specific information, actual exposures could deviate from those calculated due to differences in exposure frequencies, contact rates, absorption efficiencies (dermal exposure), exposure durations, body weight and lifespan.

The exposure point concentrations used in this assessment are the 95 percent UCLs for the arithmetic averages (means) derived from analytical sampling data.

The data used provide only a brief "snapshot" in time. Concentrations to which a person could be exposed over a lifetime could vary considerably from these values.

The reference toxicity values used in this assessment are the most current values approved by EPA. Reference toxicity values are not available for all compounds to which one could be exposed nor for all routes of exposure. In particular, the use of oral toxicity values in the estimation of dermal toxicity should be viewed with a great deal of uncertainty. Also, the lack of available toxicity values for lead and the lack of an oral slope factor for arsenic should be taken into account when considering the uncertainty associated with the baseline risk assessment.

Lead is considered by EPA to be a probable human carcinogen and a systemic toxicant, but no slope factors or RfDs are currently available. The primary toxic effects of lead are on the nervous system and hemoglobin synthesis. The reason no RfD is available is because a lower threshold for toxicity has not been observed. Effects on the nervous system (child development) and the blood are observed even at very low blood lead levels (10-15 $\mu g/dL$). Slope factors have not been derived due to the lack of quantitative dose-response data.

Even the use of EPA toxicity values involves considerable uncertainty. For example, the use of slope factors or unit risk estimates should be qualified by the following considerations. First, in fitting data to mathematical models, a number of assumptions are made in order to correlate the experimental data to a predictive model. When deriving slope factors, these health-related assumptions are made in a conservative manner. Second, the relative weight of evidence that various chemicals can cause cancer is not equal. The weight of evidence that a chemical is a potential carcinogen should be taken into account when utilizing a potency or slope factor. The EPA weight of evidence classification system for carcinogenicity is as follows:

Group	Description
A	Human Carcinogen - Sufficient evidence from epidemiological studies to support a casual association between exposure and cancer.
B1	Probable Human Carcinogen - Limited evidence of carcinogenicity in humans from epidemiological studies.
B2	Probable Human Carcinogen - Sufficient evidence in animals, inadequate evidence of carcinogenicity in humans.
C	Possible Human Carcinogen - Limited evidence of carcinogenicity in animals.

D	Not Classified - Not classifiable as to human carcinogenicity.
E	No Evidence of Carcinogenicity - Evidence of noncarcinogenicity for humans.

Third, by using the 95th percentile upper confidence limit slope of the dose-response curve, the upper limits of lifetime cancer risk are being estimated. Thus, the actual risks of exposure to a potential carcinogen may be overestimated but are not likely to exceed the estimated risk.

Ecological Evaluation

A baseline ecological evaluation is conducted to assess potential impacts of contaminants on ecological receptors (non-human, non-domesticated species). This assessment is conducted in parallel with the human health evaluation and uses much of the same information. This ecological evaluation consisted of several steps including:

- site characterization;
- data evaluation (selection of chemicals of concern);
- exposure assessment;
- toxicity evaluation; and
- risk characterization.

Site Characterization

Site characterization entails defining the vegetation, wildlife and ecosystems in the vicinity of the site which could be impacted by hazardous contaminants released at the site. Any endangered, threatened or protected species which might be present in the area will be noted. Most of this information is obtained from previous reports including the Integrated Land Use Management Plan (ILUMP) for Volk Field ANGB [Chryst, 1987], the Environmental Assessment (EA) for Hardwood Range [U.S. Air Force, 1989], letters from the U.S. Department of Interior [1988a, 1988b, 1989a, 1989b] and the WIDNR [1990]. General site characterization information for the Base and Hardwood Range comes from the aforementioned sources and is summarized below.

There are three major types of habitat for terrestrial wildlife at the Base and Hardwood Range including open fields, woodlands and wet bottomlands. The open field habitat supports populations of red-tailed deer, red fox, coyote, woodchuck and songbirds. The woodland habitats support white-tailed deer, raccoon, coyote, striped skunk, grey and red squirrels, ruffed grouse, turkey, woodcock and songbirds. The wet bottomlands support populations of white-tailed deer, raccoon, ruffed grouse, woodcock and songbirds.

Birds of prey including red-tail hawks, kestrels and marsh hawks are also common at Volk Field. Nests have been spotted on or near the bluff in the southern part of the Base. Marsh hawks are commonly observed over open fields and marshes.

Aquatic habitat at the Base and Hardwood Range consists of two waste-water treatment reservoirs, a small manmade pond and the extensive system of manmade drainage ditches. The treatment reservoirs support populations of muskrat, snapping turtles, painted turtles, shore birds, ducks, geese and miscellaneous migratory waterfowl. Small fish and northern pike live in the drainage ditches. These ditches also support populations of muskrat, raccoon, mink, beaver and waterfowl. The manmade pond supports populations of muskrat, beaver, minnows and migratory waterfowl.

A complete listing of species present at the Base and Hardwood Range and estimates of their relative abundance are given in the ILUMP [Chryst, 1987] and the EA for Hardwood Range [U.S. Air Force, 1989].

A number of species which are classified as either threatened or endangered by the U.S. Fish and Wildlife Service or the WIDNR are likely to be present within a 50-mile radius of the Base. These include the Massassauga rattlesnake, Blanding's turtle, Kirtland's warbler, double-crested cormorant, bald eagle and osprey. Bald eagles have been sited at the Base and Hardwood Range. Peregrine falcons have also been spotted occasionallv at the Base.

The areas surrounding the Base consist of farmland, woodland and marshy areas. There are a number of wildlife refuges and/or management areas in the vicinity. The Necedah National Wildlife Refuge (NWR) is located to the south and west of Hardwood Range and 5 miles to the northeast of the Base. The refuge covers an area of approximately 65 square miles. The primary purpose of the refuge is to provide stop-over habitat for migrating waterfowl during the fall (peaking from mid-September through early November). The thousands of Sandhill Cranes and geese which stop at the refuge leave in the morning to feed in nearby fields, particularly to the northeast (cranes) and southwest (geese) and return at sundown. Bald eagles have been sited within the boundaries of the refuge but are probably not nesting within the refuge .

Other areas of interest and/or concern located near Hardwood Range include:

- The Sandhill Wildlife Demonstration Area is located north of the Necedah NWR in southwestern Wood County. The area is managed by the State of Wisconsin for Sandhill cranes and upland wildlife.
- The Wood County Wildlife Area is located north of the Necedah NWR. The area is managed by the State of Wisconsin for upland wildlife.

- The Meadow Valley Wildlife Area is located directly west and south of the Necedah NWR. The area is owned by the U.S. Fish and Wildlife Service and is leased and managed by the State of Wisconsin for wildlife management.
- Petenwell Flowage Dam Area is located 2.75 miles east of the Necedah NWR on State Highway 21. The area is a wintering ground for bald eagles and is a popular hiking and fishing spot.
- Trempealeau NWR is located on the Mississippi River adjacent to the town of Trempealeau, Wisconsin.
- The Upper Mississippi River Wildlife and Fish Refuge is located in the states of Illinois, Iowa, Minnesota and Wisconsin. A portion of the refuge is south and east of the Trempealeau NWR.
- Wisconsin State Wildlife Areas include Van Loon, Trempealeau Lake, and Whiteman Dam State Wildlife areas.

Data Evaluation

The criteria used to select chemicals of concern for the ecological assessment (e.g., inorganic concentrations in soils exceed three times the minimum background concentration, detection in 5 percent of samples, etc.) were the same criteria used to select chemicals of concern for the human health evaluation.

Toxicity Assessment

Toxicity evaluations for chemicals which affect ecological receptors are limited. The acute and chronic toxicity of chemicals detected in freshwater systems can be evaluated with the EPA's Water Quality Criteria for the protection of freshwater aquatic life. There are no similar criteria for terrestrial species or for chemicals in soils, air or groundwater. However, one can use oral LD50 (Lethal Dose, 50 percent) values which have been defined for laboratory mammals to predict which chemicals might be toxic to mammals. An acute oral LD50 is a dose of a compound which will result in the death of 50 percent of the population within a period of approximately two weeks following a single oral administration. Compounds which are administered repeatedly for longer periods of time are generally more toxic at lower doses. Thus, if a chemical has a low LD50, it will undoubtedly be more toxic to an organism which is exposed repeatedly throughout its lifespan. In this evaluation, chemicals which have acute oral LD50s will be evaluated as follows:

LD50 (mg/kg body weight)	Toxicity Category
≤50	Severely Toxic
>50 - 500	Moderately Toxic
>500 - 5000	Slightly Toxic
> 5000	Very Slightly Toxic

This scheme was described by Maxwell [1982] and was used in an ecological evaluation prepared for the EPA by CH2MHill for the Lowry Landfill [CH2MHill, 1989]. Other similar schemes exist for birds and aquatic life, but no LD50 or LC50 (Lethal Concentration, 50 percent) information was readily available for these organisms.

The available water quality criteria and acute oral LD50 values for mammals are summarized in Table 4.10. Other available toxicity information for chemicals detected at the Base and Hardwood Range is summarized in Appendix F.

Exposure Assessment

Exposure assessments will focus on identifying complete pathways of exposure for ecological receptors. Exposures for these receptors will not be quantified due to the lack of adequate reference assumptions on intake and the lack of adequate toxicity benchmarks with which to compare intakes.

Risk Characterization

Due to the lack of quantitative exposure and toxicity information, the risk characterization for ecological receptors is largely qualitative. It is possible to hypothesize about potential exposure pathways and point out which contaminants could be hazardous, but it is not possible to determine whether or not the concentrations present in media onsite are high enough to cause adverse effects. Exposure concentrations of contaminants in surface waters will be compared with water quality criteria. LD50 values for contaminants in soils and water will be evaluated according to the toxicity scale described above in order to highlight chemicals present at each site which might be toxic to mammals. Any other information relevant to potential adverse effects of chemicals on ecological receptors will be reported. Specific uncertainties for each site assessment will be highlighted.

CHEMICAL AND PHYSICAL PROPERTIES OF THE CHEMICALS OF CONCERN

Physical and chemical properties of the chemicals of concern will affect fate and transport of those chemicals in the environment. Table 4.11 summarizes several

important physical and chemical properties for many of the selected chemicals of concern.

The water solubility of a substance is a critical property affecting environmental fate. Highly-soluble chemicals can be rapidly leached from wastes and soils and are generally mobile in groundwater. Solubilities can range from less than 1 mg/L to totally miscible, with most common organic chemicals falling between 1 mg/L and 1,000,000 mg/L [Lyman et al., 1982]. The solubility of chemicals which are not readily soluble in water may become enhanced in the presence of organic solvents (e.g., toluene), which are more soluble in water. As shown in Table 4.11, 1,1-dichloroethane, 1,3-dichloropropene, tetrachloroethylene, phenol, trans-1,2-dichloroethylene, trichloroethylene and benzene have the highest solubilities of the contaminants detected. Because of their relatively high solubilities (greater than 1000 mg/L) these compounds are expected to be mobile in the soil.

Volatilization of a compound will depend on its vapor pressure, water solubility, and air diffusion coefficient. Vapor pressure, a relative measure of the volatility of chemicals in their pure state, ranges from roughly 0.001 to 760 millimeters of mercury (mm Hg) for liquids. The Henry's Law Constant, which combines vapor pressure with solubility, is more appropriate than vapor pressure alone for estimating releases from water to air for compounds having Henry's Law Constants. Compounds with Henry's Law Constants greater than 10^{-3} atmospheres - cubic meter per mole (atm-m^3/mole) can be expected to readily volatilize from water; those with values ranging from 10^{-3} to 10^{-5} (atm-m^3/mole) are associated with moderate volatilization, while compounds with values less than 10^{-5} (atm-m^3/mole) will only volatilize from water to a limited extent [Lyman et al., 1982]. Trichloroethylene, tetrachloroethylene and fluoranthene have the highest Henry's Law Constants of the contaminants detected on site.

The organic carbon partition coefficient (K_{oc}) reflects the propensity of a compound to sorb to organic matter found in soil. The normal range of K_{oc} values is 1 to 10^7 milliliters per gram (mL/g), with higher values indicating greater sorption potential. Chemicals which have a strong tendency to sorb to organic matter (i.e., chemicals with high K_{oc} values) will move more slowly in the environment than chemicals with low K_{oc} values. PAHs have the highest K_{oc} values of the compounds detected. These compounds, therefore, are expected to be strongly adsorbed by organic matter present in the soil and have relatively low mobilities.

Chemicals detected at the Base and used in the baseline risk assessment can be classified into several categories according to their similarity in chemical structure and/or physiochemical properties (factors which would influence mobility in the environment) as follows:

- **volatile organics:** trichloroethylene, 1,3-dichloropropene, tetrachloroethylene, benzene, ethylbenzene, toluene, xylenes.

- **semivolatile organics**: benzo(a)anthracene, benzo(a)pyrene, benzo(b) fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, bis(2-ethylhexyl)phthalate, chrysene, dibenzo(a,h)anthracene, fluoranthene, phenanthrene, pyrene, acenaphthylene, fluorene, 2-methylnaphthalene, naphthalene, phenol.
- **other**: TPH.
- **metals**: cadmium, chromium, copper, lead, nickel, zinc.

Toxicity profiles for each of the detected analytes have been included in Appendix F.

CONTAMINANT FATE AND TRANSPORT

The previous subsection described the important physical and chemical properties of the contaminants detected at the Base. This subsection describes how these properties affect the persistence and transport of these compounds in the environment.

Volatile Organics

Volatile organic compounds are low molecular weight compounds whose presence in soil and water samples collected at the Base is due to their widespread use as solvents and fuel additives. These compounds generally have high Henry's Law Constants, moderate to high solubilities and low K_{oc} values. This indicates that these compounds are expected to be mobile in the environment. While dichlorobenzenes are included with the volatile organics, these compounds have much higher K_{oc} values than the other compounds in this class. Therefore, these compounds would be expected to be more strongly adsorbed by soils and therefore less mobile than the other compounds in this class.

The soils at the Base consist primarily of silts and sands with some limited clay lenses. Because groundwater at the Base is relatively shallow (less than 10 feet) the migration of these compounds to the groundwater is likely. As described in Sections 5 through 13, several of these compounds have been detected in the groundwater at the Base.

The properties that enhance the mobilities of these compounds also make them more available for degradation. Because of their high vapor pressures these compounds would be expected to volatilize from surface soils.

Semivolatile Organics

Semivolatile organic compounds detected in soil and water collected at the Base consisted of PAHs and phthalate esters. The semivolatile organics have higher molecular weights than the volatile compounds. They also have lower vapor pressures, lower solubilities, and higher K_{oc} values. These compounds are expected to be strongly adsorbed by site soils and therefore less mobile in the environment.

While the semivolatile compounds are not soluble in water, they are soluble in non-water solvents such as fuels. The application of fuels to the ground could enhance the mobility of these compounds.

Petroleum Hydrocarbons

Petroleum hydrocarbon concentrations are measured using fluorocarbon-113 extraction of organic compounds with medium to high molecular weights. Low molecular weight compounds and light fuels, such as gasoline, volatilize during the analysis and, therefore, have low recoveries. The aliphatic organics which constitute most of the recoverable petroleum hydrocarbons are generally less toxic than the volatile organic compounds. The primary health concern associated with chronic exposure is through ingestion of contaminated food and water.

The fate of petroleum hydrocarbons in soils is affected primarily by their distribution, volatility, and leaching potential. Low molecular weight aromatic hydrocarbons such as benzene, toluene, and xylenes partially evaporate. The remaining hydrocarbons will migrate to different depths in the soil column and possibly to groundwater.

The aliphatic organics which represent the residual compounds have negligible water solubilities, low vapor pressures and high adsorption coefficients. The proportion of petroleum hydrocarbons that will adsorb to soil particles rather than continue migration depends on the type of soil, the particular petroleum product involved, the volume of the release, and the amount of rainfall. In general, leaching to groundwater is favored by high rainfall and permeable soils, and increases for petroleum compounds with high solubility and low adsorption coefficients.

Most compounds measured as petroleum hydrocarbons are relatively persistent in the environment. Biodegradation is the main elimination mechanism, but rates are fairly slow, especially for cyclic or aromatic hydrocarbons. Complete biodegradation of petroleum hydrocarbons may require many years or decades [API, 1986].

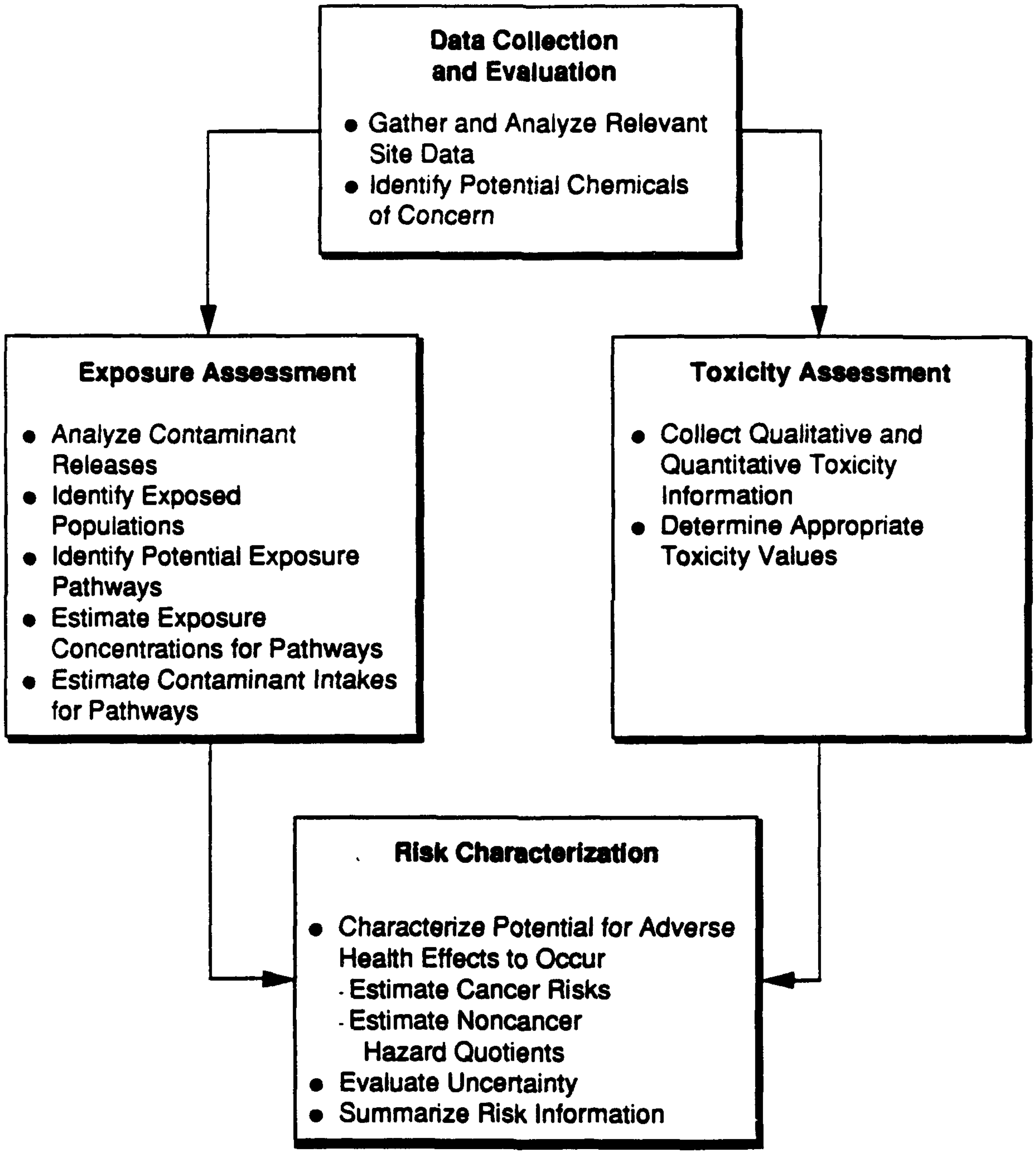
Metals

Metals occur naturally in the environment, principally as cations within the crystal lattice structure of minerals. Unlike the organic compounds discussed above, metals, which are chemical elements, are not degradable through biological or chemical actions and can be considered infinitely persistent in the environment. However, metals can be oxidized or reduced through the actions of microorganisms that can change their chemical and physical properties and therefore their mobility. For example, biomethylation of lead and mercury (the addition of a methyl group) can greatly increase their mobility and reduce their soil-sorption potential.

The mobility of metals in the environment is generally low, with sorption being the factor most important in controlling their movement [EPA, December 1979]. Most of the metals detected at the Base have a high potential for sorption in the soil

and therefore, normally have low mobilities. Exceptions are arsenic in the highly soluble oxyanion form (AsO_4^{-3}) and nickel, which has the highest mobility of all the heavy metals listed. Environmental factors which influence the mobility of metals include: soil type (metals are readily sorbed by clay minerals and organic matter); pH (metals are more soluble at low pHs); biomethylation; and chemical oxidation and reduction.

BASELINE RISK ASSESSMENT
VOLK FIELD ANGB, WI



Source: Risk Assessment Guidance for Superfund, v.1
EPA/540/1-89/002

GAI077CTA/MAC/PM4/021192

TABLE 4.1
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA FOR ANALYTES DETECTED IN SURFACE WATER VOLK FIELD ANGB, WI

	State of Wisconsin Warm Water Forage Fish, Limited Forage Fish, and Limited Aquatic Life Communities			Federal Ambient Water Quality Criteria: Human Health	Federal Ambient Water Quality Criteria: Freshwater Aquatic Life		
Contaminant	Acute Toxicity at Hardness of 50 (µg/L)	*Human* Threshold Criteria (µg/L)	Threshold Concentration for *Substances Causing* Taste and Odor in Water (µg/L)	*Consumption* of Organisms (µg/L)	Acute Concentration (µg/L)	Chronic Concentration (µg/L)	*Proposed* RCRA Water Action Level[a] (µg/L)
Bis(2-ethylhexyl)phthalate	--	3,400,000	--	5.9[b]	--	--	3
Copper[e]	8.63	--	--	--	50[c]	30[c]	--
Lead	69.96	50	--	--	82[c]	3.2[c]	--
Mercury	1.53	880	--	0.15	2.4	0.012	--
Thallium[e]	--	3,000	--	7.2	--	--	3[d]
Total dissolved solids	--	--	--	--	--	--	--
Zinc	62.69	--	5,000	--	120[c]	110[c]	--

(a) To be considered criteria.
(b) Criterion based on carcinogenity (10^{-6} risk).
(c) Criterion expressed as a function of total hardness (mg/L). Value displayed corresponds to a total hardness of 100 mg/L.
(d) Criterion shown is applicable to various thallium compounds (i.e., thallium acetate, thallium carbonate, thallium chloride, thallium nitrate, and thallium sulfate)
(e) Detected in background sample only.

References:

(1) "ARAR's Q's + A's: Compliance with Federal Water Quality Criteria," Office of Solid Waste and Emergency Response, U.S. EPA, Washington, D.C., June 1990.
(2) Wisconsin Administrative Code NR102, July 1989.
(3) Wisconsin Administrative Code NR105, March 1989.
(4) 55 FR Appendix A, July 27, 1990.

TABLE 4.2
APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS FOR ANALYTES DETECTE IN GROUNDWATER VOLK FIELD ANGB, WI

Contaminant	Wisconsin Public Health and Welfare Groundwater Quality Standards Enforcement Standard (µg/L)	Preventive Action Limit* (µg/L)	Safe Drinking Water Act Current MCL (µg/L)	MCLG (µg/L)
Volatile Organics				
Benzene	5	0.067	5	0
Chloroform	6	0.6	100[(a)]	100[(a)]
1,1-Dichloroethane	850	85	--	--
trans-1,2-Dichloroethylene	100	20	100	100
trans-1,3-Dichloropropene	--	--	--	--
Ethylbenzene	1,360	272	700	700
Toluene	343	68.6	1,000	1,000
1,1,1-Trichloroethane	200	40	200	200
Trichloroethylene	5	0.18	5	0
Xylenes	620	124	10,000	10,000
Semivolatile Organics				
Bis(2-ethylhexyl)phthalate	--	--	--	--
Diethyl phthalate	--	--	--	--
2,4-Dimethylphenol	--	--	--	--
Fluorene	--	--	--	--
2-Methylnaphthalene	--	--	--	--
Naphthalene	--	--	--	--
Pentachlorophenol	300	30	1	0
Phenol	--	--	--	--
Inorganics				
Arsenic	50	5	50	--
Beryllium	--	--	--	--
Cadmium	10	1	5	5
Chromium (VI)	50	5	100[(b)]	100[(b)]
Copper	1,000	500	1,300	1,300
Lead	50	5	15[(c)]	0
Nickel	--	--	--	--
Silver	50	10	100[(d)]	--
TDS	--	--	500,000[(d)]	--
Thallium[(e)]	--	--	--	--
Zinc	5,000	2,500	5,000[(d)]	--

*Clean-up objectives for remedial design/remedial action. Not considered ARARs for risk assessment.

MCL - Maximum Contaminant Level.
MCLG - Maximum Contaminant Level Goal.
(a) Total trihalomethanes.
(b) Total chromium.
(c) Action Level; not an MCL.
(d) Secondary standard.
(e) Detected in upgradient well only.

References:
(1) Wisconsin Administrative Code NR140, October 1990.
(2) 56 FR 3526 and 3578, January 30, 1991.
(3) 56 FR 26463, June 7, 1991.
(4) 56 FR 30274, July 1, 1991.
(5) 40 CFR Part 141, Sec. 141.50 - 141.62, 1991.

TABLE 4.3
TO BE CONSIDERED CRITERIA
FOR ANALYTES DETECTED IN GROUNDWATER
VOLK FIELD ANGB, WI

Contaminant	Safe Drinking Water Act Proposed MCL (μg/L)	Safe Drinking Water Act Proposed MCLG (μg/L)	EPA Office of Drinking Water Health Advisories DWEL (μg/L)	EPA Office of Drinking Water Health Advisories 10^{-4} Cancer (μg/L)	Proposed RCRA Corrective Action Levels (μg/L)
Volatile Organics					
Benzene	--	--	--	100	--
Chloroform	--	--	500	600	6
1,1-Dichloroethane	--	--	--	--	--
trans-1,2-Dichloroethylene	--	--	--	--	--
trans-1,3-Dichloropropene	--	--	--	--	10
Ethylbenzene	--	--	3,000	--	4,000
Toluene	--	--	5	--	10,000
1,1,1-Trichloroethane	--	--	1,000	--	3,000
Trichloroethylene	--	--	300	300	--
Xylenes	--	--	60,000	--	70,000
Semivolatile Organics					
Bis(2-ethylhexyl)phthalate	4	0	0	300	3
Diethyl phthalate	4	0	--	--	30,000
2,4-Dimethylphenol	--	--	--	--	--
Fluorene	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--
Naphthalene	--	--	100	--	--
Pentachlorophenol	--	--	1,000	30	1,000
Phenol	--	--	20,000	--	20,000
Inorganics					
Arsenic	--	--	--	3	--
Beryllium	1	0	200	0.8	8
Cadmium	--	--	20	--	--
Chromium (VI)	--	--	200[a]	--	--
Copper	--	--	--	--	--
Lead	--	--	--	--	--
Nickel	100	100	600	--	700
Silver	--	--	200	--	--
TDS	--	--	--	--	--
Thallium[c]	2/1[b]	0.5	2	--	--
Zinc	--	--	4,000	--	--

MCL - Maximum Contaminant Level.
MCLG - Maximum Contaminant Level Goal.
DWEL - Drinking Water Equivalent Level. A lifetime exposure concentration protective of adverse non-cancer health effects that assumes all of the exposure to a contaminant is from a drinking water source.
(a) Total chromium.
(b) EPA proposes two MCLS based on practical quantitation levels of five times and ten times the method detection limit.
(c) Detected in upgradient well only.

References:

(1) 55 FR 30371, July 25, 1990.
(2) "Drinking Water Regulations and Health Advisories", Office of Drinking Water, U.S. EPA, Washington, D.C., November 1990.
(3) "Draft Guide to Drinking Water Health Advisories", Office of Drinking Water, U.S., EPA, Washington, D.C., August, 1988.
(4) 55 FR Appendix A, July 27, 1990.

TABLE 4.4
TO BE CONSIDERED CRITERIA
FOR ANALYTES DETECTED IN SOIL AND SEDIMENTS
VOLK FIELD ANGB, WI

Contaminant	Proposed RCRA Soil Action Levels (mg/kg)
Volatile Organics	
Benzene	--
Ethylbenzene	8,000
Tetrachloroethylene	10
Toluene	20,000
Trichloroethylene	60
Xylenes	200,000
Semivolatile Organics	
Benzo(a)anthracene	--
Benzo(b)fluoranthene	--
Benzo(k)fluoranthene	--
Benzo(g,h,i)perylene	--
Benzo(a)pyrene	--
Benzoic acid[a]	--
Bis(2-ethylhexyl)phthalate	50
Chrysene	--
Dibenzo(a,h)anthracene	--
Diethyl phthalate	60,000
Fluoranthene	--
Indeno(1,2,3-cd)pyrene	--
2-Methylnaphthalene	--
Naphthalene	--
Phenanthrene	--
Pyrene	--
Pesticides/PCBs	
Alpha Chlordane	0.5
4,4'-DDD	3
4,4'-DDE	2
4,4'-DDT	2
Inorganics	
Arsenic	80
Beryllium[a]	0.2
Cadmium	40
Chromium (VI)	400
Copper	--
Lead	500-750[2]
Mercury	20
Nickel	2,000
Silver[a]	200
Zinc	--

[a] Detected in background sample only.

References:

(1) 55 FR Appendix A, July 27, 1990.

(2) Reference = EPA, 1989b.

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TABLE 4.5
BACKGROUND METAL CONCENTRATIONS IN SOIL
VOLK FIELD ANGB, WI

Compound	VF1 SB13(a) (mg/kg)	VF1 SB16 (mg/kg)	VF2 SB5 (mg/kg)	VF9 SB3 (mg/kg)	VF10 SB3 (mg/kg)	Southcentral Wisconsin * (mg/kg)
Chromium	2.3	2.0	1.2	2.7	2.6	2 to 5
Copper	1.7	1.2	1.2	2.5	2.3	1
Nickel	U	U	U	1.9	1.5	0.5 to 15
Zinc	3.8	3.4	4.6	13.1	3.7	28 to 45
Arsenic	U	U	U	U	U	6.5
Mercury	U	U	U	0.013	U	0.032 to 0.13
Lead	1.2	1.6	U	3.9	U	less than 10

U Not detected

NR Not recorded

(a) Duplicate of VF1-SB16.

* Source: Shacklette and Boerngen, 1984. Ranges are for mean concentrations at three sampling locations in southcentral Wisconsin.

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TABLE 4.6
SUMMARY OF EXPOSURE VARIABLES
SOIL AND SEDIMENT PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
Chemical Concentration in soils and sediments (mg/kg)	All Receptors	Value used is the 95 percent UCL of measured concentrations in soils and sediments. May tend to overestimate risk	ES Analytical Data
Ingestion Rate:			
100 mg/day	Child Trespassers	Average for older child (> age 6).	
100 mg/day*	Workers and Adult Residents	Average for outdoor yard/garden work during May-October.	EPA, 1991c
200 mg/day*	*Child Residents*	EPA standard value for children ages 1 to 6.	EPA, 1991c
Exposure Frequency:			
120 events/year (dermal)	Child Trespassers	Assumes outdoor activities would occur 5 days/week; exposure may be more or less frequent.	
30 events/year (dermal)	Adult Residents	Assumes 2 days/week from May through October.	Hawley, 1985
250 events/year (dermal)	Workers	Assumes outdoor activity 5 days/week throughout the year; exposure will be less frequent in winter.	EPA, 1991c
120 events/year (dermal)	Child Residents	Assumes 5 days/week from May through October.	Hawley, 1985

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TABLE 4.6–Continued
SUMMARY OF EXPOSURE VARIABLES
SOIL AND SEDIMENT PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
350 days/year (oral)	Child and Adults Residents	One year minus 15 days vacation.	EPA, 1991c
250 days/year (oral)*	Residents (adults and children)	Assumes exposure to sediments 5 days/week from May through October.	Professional judgement - coincides with period when temperature is not expected to be < 32°F
Available Body Surface Area:			
3120 cm2	Worker	50th percentile value for arms and hands.	EPA, 1989a
1870 cm2	Child Trespasser	50th percentile value for arms and hands for child of 9 or 10.	EPA, 1989a
8620 cm2	Adult Resident	50th percentile value for hands, arms and legs.	EPA, 1989a
3910 cm2	Child Resident	50th percentile value for hands, arms and legs for a child of 6.	EPA, 1989a
Exposure Duration:			
30 years*	Adult Resident	National upper-bound (90th percentile) time at one residence.	EPA, 1991c
6 years*	Child Residents	Maximum soil ingestion up to age 6.	EPA, 1991c
6 years	Child Trespassers	Time during which "child values" apply.	Assumed

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TABLE 4.6–Continued
SUMMARY OF EXPOSURE VARIABLES
SOIL AND SEDIMENT PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
25 years	Workers	National upper-bound (95th percentile) at one location.	EPA, 1991c
Body Weight:			
70 kg*	Workers, Adults	Standard Reference weight for an adult male. People may weigh more or less.	EPA, 1991c
35 kg	Child Trespassers	Approximate weight of child between the ages of 1 to 12.	EPA, 1989a
15 kg*	Child Residents	Approximate weight of child age 1 to 6.	EPA, 1991c
Averaging Time:			
70 years (carcinogens)*	All receptors	Conventional human lifespan. Intakes for carcinogens are averaged over the *lifespan since risk* is accrued over a lifetime.	EPA, 1991c.
ED × 365 days/year (noncarcinogens)	All receptors	Intakes for noncarcinogens are averaged over the duration of exposure.	EPA, 1991c
Soil to Skin Adherence Factor			
1.45 mg/cm2	All receptors	Value for commercial potting soil.	EPA, 1989a

TABLE 4.6–Continued
SUMMARY OF EXPOSURE VARIABLES
SOIL AND SEDIMENT PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
Absorption Factor:			
1 (oral)	All receptors	Except for the slope factors for trichloroethylene (oral), all RfDs and slope factors were not adjusted for absorption.	EPA, 1989a
0.03 (dermal; PAHs only)	All Receptors	Dermal absorption of benzo(a)pyrene	ATSDR, 1988
0.15 (dermal; organics other than PAHs)	All Receptors	Soil matrix effect.	Hawley, 1985

* Variable used in calculating exposure to sediments.

TABLE 4.7
SUMMARY OF EXPOSURE VARIABLES
GROUNDWATER AND SURFACE WATER PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
Chemical Concentration in groundwater and surface water (mg/L)	All	Value used is the 95 percent UCL of the arithmetic mean for measured concentrations in monitoring wells and surface water or the maximum concentration detected.	ES Analytical Data
Intake Rate:			
2 liters/day	Child and Adult Residents	90th percentile value for adults.	EPA, 1991c
1 liter/day	Workers	Assumes workers drink 1/2 of their water at work (*daily consumption* = 2 l/day).	EPA, 1991c
0.100 liter/hour*	Adults and Children	Incidental ingestion of groundwater such as during swimming or wading.	EPA, 1991c
Exposure Time (Surface water)			
1 hour/day*	Children and Adults	Time during which exposure occurs.	Assumed
Exposure Frequency:			
350 days/year	Child and Adult Residents	One year minus 15 days vacation.	EPA, 1991c
250 days/year	Workers	Exposure 5 days/week, 50 weeks/year.	EPA, 1991c
120 days/year*	Adults and Children	Warmer months of year.	Assumed

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TABLE 4.7–Continued
SUMMARY OF EXPOSURE VARIABLES
GROUNDWATER AND SURFACE WATER PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
Exposure Duration:			
30 years*	Child and Adult Residents	National upper-bound (90th percentile) time at one residence.	EPA, 1991c
6 years*	Child Residents	Time during which "child values" apply.	Assumed
25 years	Workers	National upper-bound (95th percentile) at one location.	EPA, 1991c
Body Weight:			
70 kg*	Workers, Adult Residents	Standard Reference weight for an adult male. People may weigh more or less.	EPA, 1989a, 1990b
15 kg*	Child Residents	Approximate weight of child between the ages of 1 and 6.	EPA, 1991c
Averaging Time:			
70 years (= 25550 days) (carcinogens)*	All receptors	Conventional human lifespan. Intakes for carcinogens are averaged over the lifespan since risk is accrued over a lifetime.	EPA, 1991c
ED × 365 days/year (noncarcinogens)*	All receptors	Intakes for noncarcinogens are averaged over the duration of exposure.	EPA, 1991c

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TABLE 4.7–Continued
SUMMARY OF EXPOSURE VARIABLES
GROUNDWATER AND SURFACE WATER PATHWAYS
VOLK FIELD ANGB, WI

Exposure Variable	Receptor	Rationale	Source
Permeability Constant:			
8.4×10^{-4} cm/hr	All receptors	Permeability of water; may underestimate dermal permeability of some organic chemicals.	EPA, 1989a
Skin surface area available for contact:			
19400 cm^2	Adult Residents	50th percentile total surface area.	EPA, 1989a
7280 cm^2	Child Residents	50th percentile total surface area. Median value for a child age < 6 years.	
Exposure Time:			
12 minutes (= 0.2 hr)	Child and Adult Residents	90th percentile time in shower/bath.	EPA, 1989a

* Variable used in calculating exposure to surface water.

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TABLE 4.8

TOXICITY VALUES FOR THE EVALUATION OF POTENTIAL NONCARCINOGENIC EFFECTS [a]
VOLK FIELD ANGB, WI

Chemical	Inhalation RfC (mg/m3)	Oral RfD (mg/kg/day)	Critical Effect: Inhalation	Critical Effect: Oral
Alpha Chlordane	ND[b]	6.0E-05[b]	NA	Liver Necrosis
Benzene	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	NA	NA
Benzo(a)pyrene	ND	ND	NA	NA
Benzo(b)fluoranthene	ND	ND	NA	NA
Benzo(g,h,i)perylene	ND	ND	NA	NA
Benzo(k)fluoranthene	ND	ND	NA	NA
Bis(2-ethylhexyl)phthalate	ND	2.0E-02	NA	Liver Effects
Cadmium (food)	ND	1.0E-03	NA	Renal Damage
Cadmium (water)	ND	5.0E-04	NA	Renal Damage
Chloroform	ND[b]	1.0E-02	NA	Liver Lesions
Chromium	2.0E-06	5.0E-03	NA	Not Defined
Chrysene	ND	ND	NA	NA
Copper	ND	1.3 mg/L[c]	NA	NA
DDD	ND	ND	NA	NA
DDE	ND	ND	NA	NA
DDT	ND	5.0E-04	NA	Liver Lesions
Dibenzo(a,h)anthracene	ND	ND	NA	NA
1,1-Dichloroethane	5.0E-01	1.0E-01	Kidney damage	None Observed
t-1,3-Dichloropropene	2.0E-02	3.0E-04	Nasal epithelial hypertrophy	Increased Organ Weights
Ethylbenzene	1.0E00	1.0E-01	NA	Hepatoxicity
Fluoranthene	ND	4.0E-02	NA	Neuropathy, Liver, Blood Changes

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TABLE 4.8–Continued

TOXICITY VALUES FOR THE EVALUATION OF POTENTIAL NONCARCINOGENIC EFFECTS [a]
VOLK FIELD ANGB, WI

Chemical	Inhalation RfC (mg/m3)	Oral RfD (mg/kg/day)	Critical Effect: Inhalation	Critical Effect: Oral
Indeno(1,2,3-c,d)pyrene	ND	ND	NA	NA
Lead	ND	ND	CNS Effects	CNS Effects
Mercury	3.0E-04	3.0E-04	Neurotoxicity	Neurotoxicity
2-Methylnaphthalene	ND	ND	NA	ND
Naphthalene	ND	4.0E-03[b]	NA	Occular and internal lesions
Pentachlorophenol	ND	3.0E-02	NA	Liver and Kidney Effects
Petroleum Hydrocarbons	ND	ND	NA	NA
Phenanthrene	ND	ND	NA	NA
Phenol	ND	6.0E-01	NA	Reduced Fetal Body Weight
Pyrene	ND	3.0E-02	NA	Renal Effects
Tetrachloroethylene	ND	1.0E-02	NA	Liver Effects
Toluene	2.0E00	2.0E-01	CNS effects	CNS Effects
Trichloroethylene	ND	ND	ND	ND
Xylenes (Total)	3.0E-01	2.0E+00	CNS Effects	Body Weight, Mortality, Hyperactivity
Zinc	ND	2.0E-01	NA	Anemia

RBC - Red Blood Cell
CNS - Central Nervous System
ND - No Data
NA - Not Applicable
(a) Source: IRIS (EPA,1991) and U.S. EPA HEAST, Annual, FY-1991.
(b) Under review by RfD/RfC Workgroup.
(c) Current drinking water standard: Data inadequate for calculation of RfD.
(d) Being reconsidered by RfD Workgroup.

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TABLE 4.9

TOXICITY VALUES FOR THE ASSESSMENT OF POTENTIAL CARCINOGENIC EFFECTS VOLK FIELD ANGB, WI

Chemical	Inhalation Unit Risk 1/(ug/m3)	Oral Slope Factor 1/(mg/kg/day)	Weight-of-Evidence Classification (a)		Tumor Site	
			Inhalation	Oral	Inhalation	Oral
Alpha Chlordane	3.7E-04	1.30E+00	B2	B2	Liver	Liver
Benzene	8.3E-06	2.90E-02	A	A	Blood Cells	Blood Cells
Benzo(a)anthracene (b)	1.7E-03	1.15E+01	B2	B2	NA	NA
Benzo(a)pyrene	1.7E-03(c)	1.15E+01(c)	B2	B2	Respiratory Tract	Stomach
Benzo(b)fluoranthene (b)	1.7E-03	1.15E+01	B2	B2	NA	NA
Benzo(k)fluoranthene (b)	1.7E-03	1.15E+01	B2	B2	NA	NA
Benzo(g,h,i)perylene	ND	ND	D	D	NA	NA
Bis(2-ethylhexyl)phthalate	ND	1.40E-02	B2	B2	NA	Liver
Cadmium	1.8E-03	ND	B1	D	Respiratory Tract	NA
Chloroform	2.3E-05	6.10E-03	B2	B2	Liver	Kidney
Chromium (d)	1.2E-2	ND	A	D	Lung	NA
Chrysene(b)	1.7E-03	1.15E+01	B2	B2	NA	NA
Copper	NA	NA	D	D	NA	NA
DDD	NA	2.40E-01	NA	B2	NA	Liver
DDE	ND	3.40E-01	B2	B2	NA	Liver
DDT	9.7E-05	3.40E-01	B2	B2	NA	Liver
Dibenzo(a,h)anthracene (b)	1.7E-03	1.15E+01	B2	B2	NA	NA
1,1-Dichloroethane	ND	ND	C	C	NA	Hemangiosarcoma
t-1,3-Dichloropropene	3.7E-05	1.80E-01	B2	B2	Lung	Total Tumors
Ethylbenzene	NA	NA	D	D	NA	NA
Fluoranthene	NA	NA	D	D	NA	NA
Indeno(1,2,3-cd)pyrene (b)	1.7E-03	1.15E+01	B2	B2	NA	NA
Lead	ND	ND	B2	B2	NA	NA
Mercury	NA	NA	D	D	NA	Kidney Effects

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TABLE 4.9–Continued

TOXICITY VALUES FOR THE ASSESSMENT OF POTENTIAL CARCINOGENIC EFFECTS VOLK FIELD ANGB, WI

Chemical	Inhalation Unit Risk 1/(ug/m3)	Oral Slope Factor 1/(mg/kg/day)	Weight-of-Evidence Classification (a)		Tumor Site	
			Inhalation	Oral	Inhalation	Oral
2-Methylnaphthalene	NA	NA	D	D	NA	NA
Naphthalene	NA	NA	D	D	NA	NA
Pentachlorophenol	ND	1.20E-01	D	B2	NA	Liver
Petroleum Hydrocarbons	NA	NA	D	D	NA	NA
Phenanthrene	NA	NA	D	D	NA	NA
Phenol	NA	NA	D	D	NA	NA
Pyrene	NA	NA	D	D	NA	NA
Tetrachloroethylene	5.2E-07	5.10E-02	B2	B2	Liver	Liver
Toluene	NA	NA	D	D	NA	NA
Trichloroethylene	1.7E-06	1.10E-02	B2	B2	Lung	Liver
Xylenes	NA	NA	D	D	NA	NA
Zinc	NA	NA	D	D	NA	NA

ND - No Data
NA - Not Applicable
A - Known carcinogen
B1/B2 - Probable human carcinogen
C - Possible human carcinogen
D - Not classified

(a) Source is IRIS (EPA, 1991) and EPA HEAST, Annunal, FY-1991.

(b) Oral and inhalation slope factors are not available for this carcinogenic PAH. The benzo(a)pyrene oral and inhalation slope factors were used for this PAH.

(c) Value for RCRA activities only. This value has not received agency-wide approval.

(d) Based on hexavalent chromium.

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TABLE 4.10

TOXICITY VALUES FOR ECOLOGICAL RECEPTORS
VOLK FIELD ANGB, WI

Chemical	Federal Water Quality Criteria ($\mu g/L$) [a] Acute (Maximum)	Federal Water Quality Criteria ($\mu g/L$) [a] Chronic (Continuous)	Lowest Mammalian Oral LD_{50} [b] [c] (mg/kg)
Alpha Chlordane	2.4	0.0043	50
Benzene	--	--	3000
Benzo(a)anthracene	--	--	--
Benzo(a)pyrene	--	--	--
Benzo(b)fluoranthene	--	--	--
Benzo(g,h,i)perylene	--	--	--
Benzo(k)fluoranthene	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	30000
Cadmium	3.9	1.1	>5000
Chloroform	28900	1240	457
Chromium (VI)	16	11	20
Chrysene	--	--	--
Copper	18	12	60
DDD	--	--	--
DDE	--	--	--
DDT	1.1	0.001	87
Dibenzo(a,h)anthracene	--	--	--
1,1-Dichloroethane	--	--	725
1,3-Dichloropropene	--	--	--
Ethylbenzene	--	--	3000
Fluoranthene	--	--	2000
Indeno(1,2,3-c,d)pyrene	--	--	--
Lead	82	3.2	5
Mercury	2.4	0.012	8[d]
2-Methylnaphthalene	--	--	2080
Naphthalene	--	--	580
Pentachlorophenol	20	13	4000
Petroleum Hydrocarbons	--	--	--
Phenanthrene	--	--	700
Phenol	--	--	50
Pyrene	--	--	300
Tetrachloroethylene	--	--	8100
Toluene	--	--	4300
Trichloroethylene	--	--	6000
Xylenes (Total)	--	--	5000
Zinc	120	110	200

(a) Source is U.S. EPA 9234.2-09/FS, Compliance with Federal Water Quality Criteria, June, 1990. Values for metals are based on an assumed hardness of 100 mg/L.
(b) Source is CH2MHill, 1989. Preliminary Endangerment Lowry Landfill, Denver, Colorado. Prepared under REM IV Contract No. 68-01-7251 for U.S. EPA.
(c) Source is Dangerous Properties of Industrial Materials, Sax and Lewis, 7th Edition, 1989.
(d) Lowest LD_{50} for inorganic mercury oxide in rats: Patty's Industrial Hygiene and Toxicology, 1981.

TABLE 4.11
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES
VOLK FIELD ANGB, WI

Chemical	CAS Number	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	K_{oc} (mL/g)
Alpha Chlordane	57-74-9	9×10^{-3}	1.0×10^{-5}	4.8×10^{-5}	2.29×10^{5}
Benzene	71-43-2	1.791×10^{-3}	9.519×10^{1}	5.43×10^{-3}	3.1×10^{1} to 1.43×10^{2}
Benzo(a)anthracene	56-55-3	Virtually insoluble: 0.009-0.014	2.2×10^{-8}	4.33×10^{-6}	2×10^{5}
Benzo(b)fluoranthene	205-99-2	1.4×10^{-2}	5×10^{-7}	1.22×10^{-5}	5.5×10^{5}
Benzo(k)fluoranthene	207-08-9	4.3×10^{-3}	9.59×10^{-11}	1.04×10^{-3}	5.5×10^{5}
Benzo(g,h,i)perylene	191-24-2	2.6×10^{-4}	1×10^{-10}	1.40×10^{-7}	1.6×10^{6}
Benzo(a)pyrene	50-32-8	3.8×10^{-3}	5×10^{-9}	2.40×10^{-6}	5.5×10^{6}
Bis(2-ethylhexyl)phthalate	117-81-7	2.85×10^{-1}	2.0×10^{-7}	1.10×10^{-5}	--
Cadmium	7740-43-9	Variable	1	NA	--
Chloroform	67-66-3	9.3×10^{3}	1.98×10^{2}	3.2×10^{-3}	4.4×10^{3}
Chromium	7440-47-3	Variable	0	NA	--
Chrysene	218-01-9	1.5×10^{-3} to 2.2×10^{-3}	6.3×10^{-9}	7.26×10^{-20}	2×10^{5}
Copper	7440-50-8	Variable	0	NA	
DDD	72548	2×10 to 1×10^{2}	10.2×10^{-7}	2.16×10^{-5}	7.7×10^{5}
DDE	72559	5×10^{-3}	6.5×10^{-6}	2.34×10^{-5}	4.4×10^{-6}
DDT	50-29-3	1.2×10^{-3} to 2×15^{-2}	1.9×10^{-7}	3.80×10^{-5}	10^{3} - 10^{7}
Dibenzo(a,h)anthracene	53-70-3	5×10^{-4}	1×10^{-10}	7.33×10^{-9}	3.3×10^{-6}
1,1-Dichloroethane	75-34-3	5.5×10^{3}	2.34×10^{2}	5.87×10^{-3}	3.0×10^{1}
1,3-Dichloropropene	542-75-6	2.7×10^{3}	2.5×10^{1}	2.43×10^{-3}	4.8×10^{1}
Ethylbenzene	100-41-4	1.61×10^{2}	9.53	8.44×10^{-3}	1.64×10^{2}
Fluoranthene	206-44-01	3×10^{-1}	1.77×10^{-2}	1.69×10^{-2}	3.8×10^{4}
Indeno(1,2,3-c,d)pyrene	193-39-5	NA	1×10^{-10}	2.96×10^{-20}	1.6×10^{6}
Lead	7439-92-1	Variable	0	NA	--
Mercury	7439-97-6	insoluble	2.00×10^{-3}	--	--
2-Methylnaphthalene	91-57-6	--	8.3×10^{-3}	5.80×10^{-6}	--
Naphthalene	91-20-3	3.17×10^{1}	8.2×10^{-2}	4.83×10^{-4}	4×10^{2} to 2.4×10^{3}

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TABLE 4.11–Continued
RELEVANT PHYSICAL AND CHEMICAL PROPERTIES
VOLK FIELD ANGB, WI

Chemical	CAS Number	Water Solubility (mg/L)	Vapor Pressure (mm Hg)	Henry's Law Constant (atm-m^3/mol)	K_{oc} (mL/g)
Nickel	7440-02-0	Variable	0	NA	--
Pentachlorophenol	87-46-5	1.4×10^{1}	1.1×10^{-4}	2.75×10^{-6}	5.3×10^{4}
Petroleum Hydrocarbons	--	--	--	--	--
Phenanthrene	85-01-8	1.0	2.1×10^{-4}	6.24×10^{-5}	1.4×10^{4}
Phenol	108-95-2	8.7×10^{4}	5.24×10^{-1}	3.97×10^{-7}	3.9×10^{1} to 9.1×10^{1}
Pyrene	129-00-0	2	1×10^{-10}	1.48×10^{-5}	3.8×10^{4}
Tetrachloroethylene	127-18-4	1.503×10^{3}	1.849×10^{1}	1.49×10^{-2}	2.1×10^{2}
Toluene	108-88-3	5.348×10^{3}	2.84×10^{1}	5.94×10^{-3}	3.7×10^{1} and 1.78×10^{2}
Trichloroethylene	79-01-6	1.10×10^{2}	6.9×10^{1}	1.03×10^{-2}	8.7×10^{1} and 1.5×10^{2}
m-Xylene	m-108-38-3	1.46×10^{2}	9	7.68×10^{-3}	m-1.66×10^{2}
o,p-Xylene	p-108-47-9 o-96-47-6	1.56×10^{2} 1.75×10^{2}	8-8.6	5.10×10^{-3}	p-2.54×10^{1} to 2.04×10^{2} o-4.8×10^{1} to 6.8×10^{1}
Zinc	7440-66-6	Variable	0	NA	--

NA - Not Applicable
-- - Not Available

References:

(1) Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Vol I/II, P. Howard, Lewis Publishers, Vol I (1989), Vol. II (1990).
(2) Air/Superfund National Technical Guidance Study Series, Vol II, 8/90 EPA-450/1-89-002a, August 1990.
(3) Water-Related Environmental Fate of 129 Priority Pollutants, Vol I/II, EPA-440/4/79-029a and b, December 1979.
(4) Superfund Public Health Evaluation Manual (K_{oc} Values only), EPA, October 1986.
(5) Physical and Chemical Hydrogeology, P. A. Domenico and F. W. Schwartz, Wiley & Sons, 1990.
(6) Groundwater and Chemicals Desk Reference, J. H. Montgomery and L. M. Welcom, Lewis Publishers, 1990.

SECTION 5
SITE 1 - FIRE TRAINING AREA

BACKGROUND

A site description, history, and a summary of past IRP activities for Site 1 is provided in this subsection.

Site Description

Site 1 - Fire Training Area (FTA) is located approximately 600 feet southeast of the intersection of Madison Boulevard and Bluff Road as shown on Figure 5.1. The site is essentially flat land covered by a gravel parking area, mowed grass and two stands of trees. The topography slopes gently to the north and northeast and rises upward towards a sandstone bluff located approximately 300 feet south of a fire training pit. Site 9, Former Landfill B, is located between Site 1 and the bluff.

The fire training pit at Site 1 lacks vegetation and is covered with approximately four inches of gravel. Reports completed in 1986 by the EPA and the Air Force Engineering Services Center (AFESC) stated the soil in the fire training pit was black, cohesive, felt oily and emitted a fuel odor. Other features at Site 1 not shown on Figure 5.1 include a small (6 feet by 15 feet) concrete slab west of the pit, a lagoon northwest of the pit and numerous monitoring wells. The lagoon is approximately four feet deep and has a plastic liner. It was constructed in 1985 to hold contaminated water before treatment as part of testing performed at Site 1. Approximately 25 monitoring wells exist at Site 1 which were installed between 1984 and 1990.

Site History

Fire training activities began at Site 1 in the 1940s and ended in 1980. The amount of fuels and flammable liquids burned at the fire training pit is not accurately known. The Phase 1 Report [HMTC, 1984] indicated prior to 1973, fire training activities used JP-4 mixed with other flammable materials including waste fuels, waste oils, solvents and possibly transformer fluids. Between 1973 and 1980, only clean, fresh JP-4 was used in fire training activities.

In addition to fire training exercises, refueling vehicles and equipment were routinely serviced in this area, which resulted in the release of fuel (AVGAS) to the ground. The maintenance of refueling vehicles reportedly contributed the largest quantity of fuel to the fire training pit, however; these fuel releases may have also occurred in areas other than the fire training pit [HMTC, 1984]. Base personnel

reported vehicle maintenance may have occurred at various locations along both sides of the unimproved access roads around Site 1. A 1965 aerial photograph shows access roads existed in different locations across the site. Some of these former roadways have been included on Figure 5.1.

The 1965 photograph also shows an aircraft located east of the fire training pit (Figure 5.1). This aircraft may have been used for fire training activities at Site 1. Base personnel indicated an aircraft was used at a burn pit approximately 300 feet east of the fire training pit. Also, barrels filled with flammable materials were used at the second burn pit. Base personnel also informed ES pieces of the plane used in the fire training exercises were buried near this burn pit. A majority of the plane is believed to be buried immediately south of the unimproved access road at Site 9, Former Landfill B (Figure 5.1).

Another potential source of fuel contamination may be the burning of munitions. The burning and burial of munitions reportedly occurred in a small pit as shown on Figure 5.1. This pit was identified by Volk Field personnel following the completion of the 1988 field effort and was not reported in the 1984 HMTC report. Fuel and/or solvents used to burn these munitions may have contributed to the contamination at Site 1.

Other information regarding the location of sources of contamination were provided in a report on the pilot-scale washing of soils contaminated with volatile organics [Downey, 1986]. This report indicates the western boundary of the Site 1 burn pit extends approximately 50 feet west of the boundary as shown on Figure 5.1. In addition, a drain hole existed in a berm surrounding the pit. This hole was located on the east side of the pit and allowed flammable liquids to escape the pit toward the east.

1987 Field Activities

An RI conducted by ES in 1987 defined the areal extent of soil contamination surrounding the fire training pit [ES, 1990b]. Fifteen soil borings were drilled to a depth of 10 feet. Forty-five soil samples were collected and analyzed for volatile and semivolatile organics, petroleum hydrocarbons, PCBs and lead.

Four groundwater monitoring wells were installed at Site 1 during the 1987 RI (Figure 5.2). Samples collected from these and several previously installed wells identified a groundwater contamination problem; however, data were insufficient to define either the horizontal or vertical extent of the contamination. Samples collected from the two cluster wells (MW-1 and MW-4) located the furthest distance downgradient of the fire training area contained aromatic hydrocarbons [ES, 1990b]. Appendix G provides tables summarizing the analytical results obtained during the 1987 field activities.

1989 Field Activities

Activities performed during the 1989 field investigation included a geophysical survey, a soil gas survey, collection of soil samples, the installation of monitoring wells and collection of groundwater samples.

A magnetics survey and electromagnetic conductivity survey were conducted over the southern part of Site 1 and over Site 9. These surveys were used to locate the munitions burn pit and locate any buried munitions prior to installing soil gas points and soil borings.

A soil gas survey was performed in the suspected location of the second fire training pit and the suspected munitions burn pit (Figure 5.3).

Sixteen soil borings (Figure 5.4) were augered and 32 soil samples were collected for chemical analysis. A sample from boring SB-16 was used to characterize background metals concentrations. Samples from borings SB-17 and SB-18 were used to characterize metals contamination in the fire training pit. Borings SB-19 through SB-31 were augered to characterize conditions at the suspected second burn pit and the suspected munitions burn pit. Samples from 0 to 2.5 feet and 5.5 to 8 feet were collected from each boring and were analyzed for volatile and semivolatile organics, lead and TPH.

Four monitoring wells were installed and sampled in 1989 (Figure 5.2). Well MW-5 was installed to further define the vertical extent of contamination and was screened from 98 to 108 feet. Wells MW-6, MW-7 and MW-8 were installed to further characterize the horizontal extent of contamination and were screened from about 50 to 60 feet. Groundwater samples were analyzed for halogenated volatiles, aromatic volatiles, lead, semivolatile organics, metals, TDS and TPH.

The 16 soil borings and four monitoring wells were surveyed for horizontal location and elevation after the completion of drilling activities.

Groundwater flow data and analytical results obtained from wells installed during this effort were used in a numerical contaminant transport model to simulate conditions at this site. The purpose was to identify appropriate monitoring well locations and screen intervals. Based on the results of this modeling effort, the number and design of additional wells were selected. These wells were installed in the next field effort as described below.

1990 Field Activities

Activities in 1990 at Site 1 included monitoring well installation and collection of groundwater samples. Placement of the wells was based on results of the 1989 investigation.

Five wells were installed to further delineate the extent and magnitude of contamination at Site 1 (Figure 5.2). Well MW-10 was installed immediately downgradient of the suspected second burn pit in the area having the greatest TPH

concentration in the soil. This well was screened from 28 to 38 feet. MW-11 was located to either define the eastern limit for the groundwater plume or to intercept potential contamination originating from the second burn pit. Wells MW-9 and MW-12 were located to work in conjunction with MW-6 to intercept a potentially narrow plume. Wells MW-9, MW-11 and MW-12 were screened from approximately 60 to 70 feet.

Well VF92-MW1 was installed at the Base boundary approximately 6,300 feet downgradient of Site 1 to determine if any contaminants from Site 1 are migrating off-Base. VF92-MW1 is located about 1,900 feet north of the eastern end of the east-west runway as shown on Figure 2.6. This well was screened from 18 to 38 feet.

Sixteen wells were sampled during the 1990 effort. The well identifications and locations are presented on Figure 5.5. Groundwater samples were analyzed for the same parameters as in the 1989 sampling effort.

All new monitoring wells and the seven cluster wells were surveyed for horizontal location and elevation.

1991 Field Activities

Field activities executed in 1991 consisted of product bail-down testing, sampling of free product, monitoring well installation and groundwater elevation measurements.

Product bail-down tests were conducted at two wells shown to contain free product in 1990, ET-3 and ET-5. These bail-down tests were completed to estimate the thickness of the free product layer beneath the fire training pit.

Two samples of the free product were collected for qualitative analysis. The samples were analyzed for gasoline (modified SW8015), benzene (SW8020) and kerosene and diesel fuels (SW80100).

One temporary monitoring well, TMW-1, was installed downgradient of the fire training pit to help define the horizontal extent of the free product layer. TMW-1 was constructed to a depth of approximately 13 feet with 0.010-inch slot screen 10 feet long.

Groundwater measurements were obtained at all monitoring wells on 30 October 1991.

RESULTS

The results of the 1989, 1990 and 1991 field investigations are discussed in this subsection.

Geology/Hydrogeology

Test borings indicate Site 1 is underlain by Pleistocene deposits consisting of mostly fine, yellowish brown sand with occasional clay lenses to a depth of about 15

to 20 feet, where weathered Cambrian sandstone occurs. The sandstone is mostly fine-grained and ranges from yellowish brown to grayish orange in color. The location of a hydrogeologic cross-section prepared from boring log data for Site 1 is shown on Figure 5.6. The cross-section is presented on Figure 5.7. Soil boring and well construction logs are presented in Appendix B.

Depth to groundwater across the site ranges from about 13 to 17 feet below land surface (BLS). Groundwater elevations measured on 13 November 1990 show groundwater flow direction toward the northeast with an average horizontal gradient of 0.003 ft/ft (Figure 5.2). Vertical gradients in the aquifer are almost nondiscernible. For example, the downward gradient between shallow well MW-1 and the intermediate well MW-4 is approximately 0.002 ft/ft. The vertical gradient at the site decreases with depth until the equipotential lines become almost vertical indicating a more horizontal component of flow. This is demonstrated between well MW-4 and the deepest well at the site, MW-5, where the gradient is not measurable. Water elevations for November 1990 are presented in Table 2.4 (Section 2 - Environmental Setting). A summary of all groundwater elevation data is presented in Appendix B.

The groundwater flow velocity at this site in the Cambrian sandstone is estimated to be about 1.76 ft/day or 640 ft/yr. This is based upon a hydraulic conductivity of approximately 877 gpd/ft^2 or 117 ft/day (estimated from a 1988 pump test) [ES, 1990b], a hydraulic gradient of 0.003 ft/ft and an effective porosity of 0.2 [Bouwer, 1978].

Geophysical Survey Results

Electromagnetic conductivity and magnetometry surveys were conducted over the fire training pit, suspected second burn pit, suspected munitions burn pit and Site 9. The survey objectives were to locate possible buried munitions prior to intrusive sampling and to aid in the placement of soil borings and soil gas sampling probes. The areas of magnetic and electromagnetic anomalies have been labeled A through F on Figure 5.8.

Electromagnetic and magnetic anomalies coincided at three locations: B, D and E. In all three instances the electromagnetic conductivities were high which is indicative of buried metal, and the magnetic anomalies suggested the presence of buried ferromagnetic material. The anomaly at B may possibly be caused by unidentified buried metal objects. The anomaly at D may correspond to the location of the munition burn pit. The anomaly at E corresponds to the suspected location of a buried C-47 aircraft. The anomalies at A, C and F have been attributed to surface features. However, none of these possibilities have been confirmed. A more detailed discussion of the geophysical surveys including additional figures and tabulated raw data has been included in Appendix C.

Soil Gas Survey Results

This subsection provides a summary of the soil gas survey results. A complete account of the soil gas survey is included in Appendix D.

The 1989 soil gas survey focused on the suspected second burn pit, suspected munitions burn pit and other areas where fuel contamination may have been present. The fire training pit area had been investigated by a previous soil gas survey.

Eighty-one soil gas points were installed at a depth of five feet. These locations are presented on Figure 5.3. In addition, vertical profile readings were obtained at two locations in the area of the suspected second burn pit. One vertical profile contained three points at 2.5, 5.0 and 7.5 feet. The other vertical profile was obtained at 2.5 and 5.0 feet. Thus, the 1989 soil gas survey consisted of a total of 84 soil gas points.

The only 1989 test point placed in the fire training pit was collected as a headspace sample. Volatile organics in the headspace gases were too concentrated to quantify. A total of fifty-nine soil gas samples were collected in the vicinity of the suspected second burn pit. No volatile organics were detected in the samples from this area. However, a hand augered sample obtained from this area during an earlier investigation detected 16 ppb of toluene in the headspace gases. Twelve samples were collected near the suspected munitions burn pit. TCE at concentrations of 73 to 162 ppb were identified in three samples (Figure 5.3). No other organic constituents were detected in these samples.

The remaining soil gas points were collected along the unimproved access roads that are currently in use. These samples were collected to identify refueling equipment servicing areas beyond the visible burn pit. No volatile organics were detected in these soil gas samples.

Soil Sample Results

Soil samples obtained from the fire training pit during the 1987/1988 RI were analyzed for organic contaminants and lead [ES, 1990b]. The area is characterized by TPH concentrations in excess of 100 mg/kg. The maximum detected concentration was 22,000 mg/kg at SB-1. The elevated TPH concentrations extended to a depth of at least 8.5 feet. Benzene, ethylbenzene, toluene and xylenes (BETX) were also detected in soil samples from this area. The sum of the concentrations of BETX compounds was in excess of 100 mg/kg in several samples. The maximum concentration of benzene was 19 mg/kg. Trichloroethylene (TCE) was detected in soil samples from this area at a maximum concentration of 0.041 mg/kg [ES, 1990b].

Sixteen soil borings were drilled during the 1989 field effort at Site 1. The boring locations were chosen to further characterize the fire training pit, suspected second burn pit and suspected munitions burial pit. Soil samples collected from the

fire training pit during the current RI were only analyzed for inorganic compounds. The remaining samples collected were analyzed for volatile and semivolatile organics, lead and TPH. Table 5.1 summarizes the detected analytes in Site 1 soil samples.

Four soil samples were collected from the fire training pit and analyzed for priority pollutant metals. The results were compared to metals concentrations found in a sample obtained from a background location at Site 1 (SB-16 on Figure 5.9). Copper, zinc and lead were found in the 1 to 3 feet sample from SB-18 at concentrations above background levels from this location. Chromium and nickel were also detected above the Site 1 background levels but at concentrations consistent with naturally occurring southcentral Wisconsin levels (Table 4.5). Lead was detected at a concentration of 100 mg/kg in the 1 to 3 feet sample from SB-18 compared to the background concentration of 1.6 mg/kg (Figure 5.9). For evaluation in the risk assessment, metal concentrations for the site were compared to all background concentrations collected and presented in Table 4.5.

The elevated lead levels in SB-18 probably resulted from leaded fuels. In past groundwater sampling activities, lead was detected in concentrations significantly above background in wells ET-3 and ET-5 [ES, 1990b]. These two wells are adjacent to SB-18. The Wisconsin Enforcement Standard and the Federal MCL for lead in groundwater were exceeded in samples collected from ET-3 and ET-5 in the previous RI effort [ES, 1990b].

Twenty-one soil samples were collected from ten soil borings augered near the suspected second burn pit. Samples were collected from 0 to 2.5 feet BLS and 5.5 to 8.0 feet BLS in each soil boring and the 10.0- to 12.5-foot level in SB-23. All samples were analyzed for halogenated volatiles, aromatic volatiles, semivolatiles, TPH and lead. Halogenated volatiles and semivolatiles were not detected in any of the 21 samples. Lead concentrations in all samples were not significantly greater than the background level. Low levels of toluene (less than 1 mg/kg) were detected in three samples in borings SB-19 and SB-20. TPH concentrations of 485 mg/kg and 380 mg/kg were detected in samples from the upper 2.5 feet in borings SB-23 and SB-29 respectively. TPH was detected at very low levels in samples from borings SB-30 and SB-31. Detected VOCs and TPH are presented on Figures 5.10 and 5.11.

Soil borings SB-24, SB-25, and SB-26, were located around the suspected munitions burn pit. Two samples were collected from each boring at depths of 0 to 2.5 feet and 5.5 to 8.0 feet. Neither halogenated nor aromatic volatiles were detected in the six samples. Bis(2-ethylhexyl)phthalate was detected in both samples from SB-24. A concentration of 0.650 mg/kg was detected in the surface sample and a concentration of 1.1 mg/kg was estimated in the deeper sample. Concentrations of TPH and lead (Figures 5.9 to 5.11) were detected in all six samples. Lead concentrations were found to be slightly higher than the

concentration found in the background sample. The levels of lead in soils are well below the criteria identified (Table 4.4). It is possible that the lead detected in this area may be the result of activities associated with the burning of spent munition which would have contained lead slugs. Samples obtained from borings SB-24 and SB-25 had TPH in excess of 500 mg/kg. Samples from SB-26 had TPH levels of 2 mg/kg and 36 mg/kg.

The estimated extent of soil contamination at Site 1 is defined in Figure 5.12. The locations of all soil samples obtained in 1987 and 1989 are shown on this figure. Concentrations of organics in these samples were used to estimate the areal extent of soil contamination. It is noted that clean up criteria may not require remediation of the areas depicted in 5.12, which encompasses approximately 2,920 square yards. Assuming the soil is contaminated to an average depth of 15 feet (approximate depth to groundwater), the total volume of contaminated soil may be 14,600 cubic yards.

Groundwater Sample Results

Groundwater samples were not obtained during either the 1989 or 1990 field investigations from the wells that were obviously contaminated; however, during the 1987 RI samples from the seven ET wells were collected and analyzed for volatile organics, semivolatile organics, pesticides/PCBs, TPH, lead and TDS. Concentrations of 1,1-dichloroethane, trans-1,3-dichloropropene, 1,1,1-trichloroethane, TCE, BETX, naphthalene, bis(2-ethylhexyl)phthalate, phenol, pentachlorophenol, lead and TDS were detected [ES, 1990b]. A summary of these analytical results are presented in Appendix G. These chemicals were considered in the preparation of the risk assessment found in the next section.

During the 1989 and 1990 field efforts at Site 1, 22 groundwater samples were analyzed. Four of the samples were collected in 1989 and the remaining 16 samples were collected in 1990. Three additional samples were collected in 1990 to screen for the presence of volatiles in wells MW-5 (2 samples) and MW-12. Volatiles were not detected in these samples. The groundwater analytical results are presented in Tables 5.2 and 5.3.

Three clusters consisting of two wells each were sampled: ET-6/MW-2, ET-7/MW-3 and MW-1/MW-4. A third well, MW-5, was added to the MW-1/MW-4 cluster in 1989. The vertical distribution of contaminants is illustrated on a hydrogeologic cross section A-A (Figure 5.13).

The groundwater samples collected from the ET-7/MW-3 cluster were the most contaminated, but contaminants were also detected in the groundwater samples collected from the MW-1/MW-4/MW-5 cluster. Groundwater samples from the ET-6/MW-2 cluster had low contaminant concentrations. The shallow well in each cluster had concentrations of benzene (37 to 2,600 μg/L), ethylbenzene, (5.3 to 370 μg/L), toluene (2.7 to 1,200 μg/L) and xylenes (1.7 to 1,100 μg/L). The benzene

concentration in all four samples exceeds the federal MCL and Wisconsin Enforcement Standard of 5 µg/L. The WI Enforcement Standards for toluene (343 µg/L) and xylenes (620 µg/L) and the WI Preventive Action Limit for ethylbenzene (272 µg/L) are also exceeded. The other contaminants detected were TCE at 1.7 µg/L in the 1990 sample from MW-1 and arsenic at 10.5 µg/L in the 1990 sample from MW-4. These concentrations exceed the WI Preventive Action Limits of 0.18 µg/L for TCE and 5 µg/L for arsenic.

In the deep well, MW-5, the detection of 12 µg/L of benzene in the 1989 groundwater sample was a concern. MW-5 was sampled on three occasions in 1990 to verify the 1989 results. Prior to sampling this well in 1990, the well was redeveloped and purged in order to confirm that the detection of benzene in 1989 was not present as a result drilling activities. No volatile organics were detected at this location in subsequent sampling events indicating that the original detection is not representative of groundwater contamination at this sampling interval.

Seven wells installed during 1989 and 1990 (MW-6 through MW-12) were positioned to help define the horizontal extent of groundwater contamination. Organic analytes were only detected at this site in groundwater samples collected from MW-8. Benzene was detected in MW-8 in both 1989 and 1990. The concentration of benzene increased from an estimated 3.4 µg/L in 1989 to 8.1 µg/L in 1990. TCE at 19 µg/L and xylenes at 3.6 µg/L were also detected in 1989, but neither was detected in 1990. The 1989 TCE concentration and the 1990 benzene concentration exceed ARARs. In 1990, pentachlorophenol was detected in the MW-8 sample at 13 µg/L which exceeds the corresponding ARAR. Figures 5.14 and 5.15 depict the detected volatile and semivolatile organic analytes at Site 1.

Lead concentrations ranging from 5.6 µg/L to 24 µg/L were detected in 1989 samples from MW-6, MW-7 and MW-8; however, the corresponding samples in 1990 had no lead detected. The detected levels of zinc, TPH and TDS are listed in Tables 5.2 and 5.3 for the samples from MW-6 through MW-12.

The approximate horizontal and vertical extent of dissolved volatile organics in groundwater has been estimated from groundwater analytical results. The estimated extent of groundwater contamination is depicted on Figures 5.14 and 5.16. Figure 5.16 presents a conceptualized extent of groundwater contamination in cross section. The concentrations of volatile organics presented have been summed, and the data from wells ET-5 and ET-3 are from results obtained in earlier investigations. Volatile organics were detected as far to the northeast as well MW-8. Surrounding wells are not contaminated. At the MW-1/MW-4/MW-5 well cluster, volatile organics in the groundwater are known to exist as deep as 43 feet, but not as deep as 98 feet. Volatiles were detected in low concentrations as deep as 60 feet in samples from MW-8 which is downgradient from the three well cluster. No volatile organics, semivolatile organics, TPH or dissolved priority pollutant metals were detected in samples from BPW-4, the Base production well east-

northeast of Site 1, or from VF92-MW1, the Base boundary well installed approximately 1 mile downgradient of Site 1 (Figure 2.6).

Free Product

Free product was found during the 1990 investigation in five of the wells within the fire training pit. Product was measured at thicknesses from 0.1 to 3.1 inches in wells WW-1, WW-5, WW-6, ET-3, ET-4 and ET-5. The thickness of free product was measured on five occasions during 1991. A summary of free product detected at Site 1 is presented in Table 5.4. The accumulation of product at this time may be attributed to the lack of on going activities at this site. Prior to the spring of 1988, research being conducted at this site required pumping of various wells at the fire training pit. Since then the area has not been disturbed which may have allowed the product to accumulate.

Two free product samples were collected and analyzed in 1991. Qualitative analyses indicated the free product mainly consists of kerosene and gasoline. These analytical results are included in Attachment A to Appendix E.

One temporary monitoring well, TMW-1, was installed in 1991 to help define the extent of the free product layer beneath the fire training pit. This well was located downgradient of the fire training pit as indicated on Figure 5.17. No separate organic phase was detected in this well. Thus, the free product layer is not thought to extend beyond this point. This information was used in estimating the areal extent of the free product layer as shown on Figure 5.17.

A bail-down test was conducted to determine the actual thickness of product at Site 1. The results are presented in an ES letter report: *Volk Field ANGB, October 1991 Field Effort* [ES, 1991]. Bail-down tests executed at ET-3 and ET-5 indicated the actual thickness of product on the water table beneath the fire training pit ranges from 0.36 to 2.2 inches. Assuming a porosity of 30 percent, the estimated volume of the free product layer is 451 to 2,706 gallons. Five to twenty percent of the total volume of free product may be recoverable by gravitational means. Thus, the estimated recoverable volume, based on twenty percent recovery, is 100 to 550 gallons.

BASELINE RISK ASSESSMENT

The following subsections present the Site 1 baseline risk assessment. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the risk assessment. Analytical results for soil and groundwater samples from the 1987 RI [ES, 1990b] were used along with the 1989 and 1990 analytical results in the preparation of this risk assessment.

A Public Health Evaluation was conducted for Site 1 in October 1988. The evaluation was based on site monitoring data collected in 1987/1988 according to

procedures specified in EPA's Superfund Public Health Evaluation Manual [October, 1986]. Subsequent to this evaluation, EPA published new guidance for conducting risk assessments and additional site monitoring data were collected. Given the changes in risk assessment methodology, particularly in the calculation of exposure, and revisions of EPA reference toxicity values, the quantitative aspects of the two assessments are not comparable. Thus the assessment presented here supersedes the 1988 Public Health Evaluation.

Selection of Chemicals of Concern

Metals, VOCs and semivolatile organic compounds were detected in soils and groundwater associated with Site 1. Based on the chemicals detected in the 1987/1988, 1989 and 1990 rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected for each medium. The available toxicity information for the chemicals detected at this site is discussed in Section 4 and Appendix F.

Surface Soils

Benzene, bis(2-ethylhexyl)phthalate, ethylbenzene, lead, 2-methylnaphthalene, TPH, tetrachloroethylene, toluene, trichloroethylene and xylenes were detected in surface soil samples from Site 1. All of these compounds were retained as chemicals of concern with the exception of bis(2-ethylhexyl)phthalate which was detected in less than 5 percent of the total number of samples. These chemicals, along with the arithmetic average, standard deviation and 95 percent UCL for the arithmetic mean are presented in Table 5.5.

Deep Soils

Of the chemicals detected in deep soils, diethyl phthalate and bis(2-ethylhexyl)phthalate were eliminated because they were detected in fewer than 5 percent of the samples. Nickel was eliminated because it was detected in only one sample and at a concentration less than three times the minimum background concentration of 1.5 mg/kg (Table 4.5, VF10 SB3). Benzene, chromium, copper, ethylbenzene, lead, 2-methylnaphthalene, naphthalene, TPH, toluene, trichloroethylene, xylenes and zinc were selected as chemicals of concern at Site 1. These chemicals, along with the arithmetic average, standard deviation and 95 percent UCL for the arithmetic mean are presented in Table 5.6. Three of the metals (i.e., chromium, copper, and zinc) in Table 5.6 were only analyzed in four samples. Because of the limited number of samples analyzed for these metals, the maximum concentration detected (and not the 95 percent UCL of the arithmetic mean) is presented in Table 5.6, and the maximum detected concentrations were used to estimate exposures.

Groundwater

A total of 24 compounds were detected in groundwater samples obtained from wells at Site 1. The following dissolved metals were not selected as chemicals of

concern as their detected concentrations did not exceed upgradient concentrations (or PQLs if upgradient was non-detect) by a factor of three or more: arsenic, copper and nickel. Trans-1,2-dichloroethane, diethyl phthalate, 2,4-dimethylphenol, fluorene, 2-methylnaphthalene and 1,1,1-trichloroethane all had frequencies of detection less than 5 percent. Table 5.7 presents the chemicals of concern detected in groundwater including the arithmetic averages, standard deviations and 95 percent UCLs for the arithmetic means of these compounds.

Human Health Evaluation

The following subsections present the Site 1 human health evaluation.

Exposure Pathways

Potential sources for contaminant release at this site include the fuels disposed at the site and any soils or groundwater in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 1 are soils at the site (both on the surface and at depth) and groundwater at and downgradient of the site.

Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point. The site is no longer in operation as a fire training area; but, the grounds are maintained, dumpsters are stored near the main burn pit and trucks routinely drive through the area. The site is centrally located on the Base and access by personnel not living or working on the Base is therefore limited; however, access to Site 1 is not controlled by fencing.

Based upon this site setting, children who currently live more than a mile northeast of the site are unlikely to wander onto the Base and should not therefore be exposed at Site 1; but, on-site Base workers could be exposed during work activities at the site. Hypothetical (future) exposure pathways would include exposures to onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 1 are summarized in Table 5.8.

Soils. Current pathways involving incidental ingestion of and dermal contact with soils at Site 1 are unlikely but possible for onsite workers. In the event that a residence were constructed at Site 1, both oral and dermal contact with soils by hypothetical residents would be more likely to occur.

Groundwater. Private water supply wells exist downgradient (northeast) of Site 1. Wells from six residences northeast of the Base were sampled for VOCs in 1984 and found to be clean [Endres and Engler, 1984]. Base production wells are also

present downgradient of Site 1 (Figure 2.7). Base production well BPW-4 and the Base boundary well VF92 MW-1 (Figure 2.6) were sampled and analyzed for the full spectrum of organic and inorganic contaminants and found not to be contaminated. Given these considerations, it is improbable that downgradient water supply wells are currently contaminated. However, chemicals were detected in monitoring wells immediately downgradient of the site and contamination of future downgradient supply wells is possible. Exposure could occur via ingestion of groundwater, dermal contact with groundwater during showering and inhalation of VOCs released from groundwater during showering. The oral pathways would apply to future employees as well as residents. The dermal and inhalation pathways would apply to future residents who might shower or bathe with the contaminated groundwater.

Surface Water. Site 1 lies within the Lemonwier River drainage basin but surface water flows on or near the site only during rainfall events. The river is more than 2 miles away from the site and contamination in surface water runoff from the site is not expected to reach the river at detectable concentrations. Migration of contaminants to the river from the site via groundwater discharge is also possible, but given the concentrations and nature of the contaminants present in groundwater, as well as the distance from the site to the river, groundwater discharge is not expected to contribute detectable contamination to the river. Therefore, the surface water pathway was not considered a major concern at Site 1, and surface water pathways were not evaluated.

Air. VOCs were detected in soil samples taken from Site 1 and it is possible that exposure could occur via inhalation of these compounds released to the air. However, exposures to contaminants released to the air from soils were not quantified since the risks associated with this pathway would be orders of magnitude lower than those associated with oral and dermal exposure to soils. Low risks are anticipated for air exposure pathways because the concentrations of contaminants in soils are minimal. Releases to air by volatilization or wind erosion would also be mitigated by dispersion and degradative processes. Furthermore, releases of chemical compounds with low or no volatility, such as lead, through wind erosion would be controlled by the vegetative cover and other nonerodible elements (oily cover, gravel, etc.) present at the site.

In this human health evaluation, risks and hazard indices were calculated for the following pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of surface Soils	Children	5.9	5.10
	Workers	5.11	5.12
	Adult residents	5.13	5.14
Dermal contact with surface soils	Children	5.15	5.16
	Workers	5.17	5.18
	Adult residents	5.19	5.20
Ingestion of deep soils	Children	5.21	5.22
	Workers	5.23	5.24
	Adult residents	5.25	5.26
Dermal contact with deep soils	Children	5.27	5.28
	Workers	5.29	5.30
	Adult residents	5.31	5.32
Ingestion of groundwater	Children	5.33	5.34
	Workers	5.35	5.36
	Adult residents	5.37	5.38
Dermal contact with groundwater(1)	Children	5.39	5.40
	Adult residents	5.41	5.42
Inhalation of VOCs released from groundwater during showering(1)	Children	5.43	5.44
	Adult residents	5.45	5.46

(1) Workers were not considered to be exposed to contaminants in groundwater via showering (dermal and inhalation) because showering is assumed to take place at their homes.

Risk Characterization

Carcinogenic Risks

A summary of the carcinogenic risks for each receptor is provided in Table 5.47. The calculated risks for each environmental media and exposure pathway are discussed below.

Soils. Carcinogenic risks for all soil exposure pathways and receptors were below EPA's target risk range of one-in-one million (1E-06) to one-in-ten-thousand (1E-04). Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated carcinogenic risks for soil pathways at Site 1 do not indicate unacceptable health risks are currently present or will occur in the future.

Groundwater. Carcinogenic risks were evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in

the groundwater (i.e., during showering) and inhalation of the volatile compounds released from the groundwater during showering.

(1) Ingestion. The calculated carcinogenic risk exceeded EPA's acceptable risk range for hypothetical (future) adults and children residing at the site. The calculated risk for both adults and children was 4E-4 or 4 excess lifetime cancer cases in ten thousand exposed. The calculated risk for a hypothetical worker who drinks groundwater from the site 5 days per week for 40 years was 1E-4 or one excess lifetime cancer case in ten thousand exposed. These risks are primarily caused by the presence of benzene and secondarily due to the presence of bis(2-ethylhexyl)phthalate and pentachlorophenol.

(2) Dermal Absorption. Dermal absorption was evaluated for hypothetical (future) site residents (adults and children) and the calculated risks were less than EPA's acceptable risk range. Thus, the calculated carcinogenic risks for this exposure do not indicate unacceptable health risks.

(3) Inhalation of VOCs. The inhalation of volatile organic compounds released from groundwater was assessed for exposures to hypothetical (future) site residents (both children and adults). The calculated risks for these hypothetical (future) receptors were 6E-4 (children) and 3E-3 (adults). These risks correspond to 6 excess lifetime cancer cases per 10,000 exposed and 3 excess lifetime cancer cases per 1,000 exposed, respectively. Both of these calculated risks exceed EPA's acceptable risk range. Benzene was the principal contaminant responsible for these unacceptable risks.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was also assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 5.48. A hazard index which exceeds 1 is an indication that adverse health effects are likely. The hazard index for each environmental media and exposure pathway are discussed below.

Soils. The hazard indices for all soil exposure pathways and receptors were less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated hazard indices for soil pathways at Site 1 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Groundwater. Noncarcinogenic health hazards were also evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the

chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from groundwater during showering.

(1) Ingestion. The hazard index for children ingesting site groundwater (3) exceeds 1 and indicates that adverse health would occur if the hypothetical (future) exposure did, in fact, occur. The chemical contaminants contributing the major portions of this index were: bis(2-ethylhexyl)phthalate; trans-1,3-dichloropropene; naphthalene; and toluene. The hazard indices for adults and on-site workers did not exceed 1 and therefore a potential health hazard should not exist for these groups of hypothetical (future) receptors.

(2) Dermal Absorption. Dermal absorption was evaluated for hypothetical (future) site residents (adults and children) and the calculated hazard indices for these potential receptors were much less than 1. Thus, this exposure route/pathway does not represent a health hazard, even with the conservative residential assumptions used in the assessment.

(3) Inhalation of VOCs. The inhalation of VOCs released from groundwater during showering was also assessed for exposures to hypothetical (future) site residents (adults and children). The calculated hazard indices for these potential receptors were equal to 1 and indicate that adverse health effects could occur if the hypothetical (future) exposure did, in fact, occur. The contaminants responsible for these hazard indices were toluene and xylene.

Ecological Evaluation

Site 1 is classified as a grassland. A stand of northern hardwoods and jack pine is directly north of the site. Stands of oak, northern hardwoods, and aspen occur to the northeast of the site next to Site 7. Cover types consisting of northern hardwood, red pine, mixed conifer, marsh, grassland, lowland brush, white pine, and bottomland hardwoods occur on the Base south of Site 1. Ecological receptors supported by these habitats are summarized in Section 4.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 1 could include:

- uptake of contaminants in soils by plants;
- ingestion and dermal contact with contaminants in soils by animals;
- uptake of contaminants in groundwater by plants; and
- inhalation of VOCs released from contaminated soils by terrestrial and avian species.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is vegetated and since the burn pit is covered with gravel and tar-like

material. Inhalation exposures resulting from VOCs released from soils are unlikely to be significant due to the low concentrations detected and limited source area.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in groundwater and soils. However, toxicity values are available to qualitatively evaluate compounds detected in soils associated with Site 1 and are presented in Table 4.10 of the Criteria for Evaluation Results section. These values include acute oral LD50s for mammals. These values can be used only to qualitatively screen for potential impacts. Acute LD50 values can only be used to highlight which of the detected chemicals might be toxic to mammals if exposure occurs for a chronic period of time, given that acceptable chronic daily exposures would be much less than the LD50. There are no similar criteria for plants or birds.

Risk Characterization

There are no toxicity values with which to evaluate exposure of flora and fauna to chemicals in groundwater. However, a method of screening the relative toxicity of a chemical detected in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils. Lead was the only compound detected in soils which is severely toxic to mammals. Copper and zinc were also selected as chemicals of concern at this site and are classified as moderately toxic. The other (organic) chemicals selected as chemicals of concern for site soils at Site 1 are either very slightly or slightly toxic with respect to acute oral toxicity for mammals.

Risk Assessment Conclusions

This subsection presents the conclusions and uncertainties of the baseline risk assessment.

Human Receptors

For humans, the only current exposure pathways which could possibly occur are incidental ingestion of and dermal contact with surface and deep soils by Base personnel. Hypothetical future pathways which are possible if someone were to build a house at the site include ingestion and dermal contact with contaminants in groundwater, ingestion of and dermal contact with contaminants in both surface and deep soils, and inhalation of VOCs released from groundwater during showering. Inhalation pathways associated with VOCs and lead in surface soils are possible but were not calculated since risks associated with these pathways are likely to be orders of magnitude lower than those associated with the oral and dermal pathways.

The unacceptable risks to humans associated with Site 1 are:

- carcinogenic risks associated with ingestion of groundwater by hypothetical residents and workers (primarily due to the presence of benzene but also because of bis(2-ethylhexyl)phthalate and pentachlorophenol);
- carcinogenic risks associated with inhalation of VOCs released from groundwater during showering by hypothetical residents (benzene);
- noncarcinogenic risks associated with ingestion of groundwater by hypothetical residents (children) (trans-1,3-dichloropropene, bis(2-ethylhexyl)phthalate, naphthalene, and toluene); and
- noncarcinogenic risks associated with inhalation of VOCs released from groundwater during showering by hypothetical residents (toluene and xylene).

It should be noted that any potential risks associated with TPH and lead in soils were not quantified in this assessment due to the lack of reference toxicity values. The risks associated with lead at Site 1 are expected to be very low since the concentrations detected in soils are well below the EPA's target lead concentration (500 mg/kg) for lead in soils at Superfund sites [EPA, 1986b]. This target concentration was based on multi-route exposure to lead contaminated soils, given a blood level of concern of 10 to 15 μg/dL. No similar criteria are available for TPH.

A general discussion of the uncertainties associated with the baseline risks assessment are given in Section 4. An important assumption made in this risk assessment is that contaminant concentrations will remain constant and not decrease over a long period of time, up to 30 years. However, organic compounds, especially benzene, detected in both soils and groundwater do degrade with time. This would result in an overall decrease in contaminant concentrations.

Ecological Receptors

Flora and fauna could be exposed by uptake of chemicals detected in soils. Burrowing animals are of particular concern. Plants could be exposed to chemicals detected in groundwater via uptake through roots.

It is not possible to quantify ecological risks associated with contaminants detected in groundwater and soils at Site 1 due to the lack of reference toxicity information. However, toxicity values are available to qualitatively evaluate compounds detected in soils. Based on reference values for acute exposure, lead and chromium are the only compounds in soils which are severely toxic to mammals. Copper and zinc, which are classified as moderately toxic were also detected. It is not possible to determine whether the concentrations present in soils are high enough to cause adverse effects.

CONCLUSIONS

Contaminants were identified in both soils and groundwater at Site 1. The contaminated soils at this site serve as a continuous source for groundwater contamination, and ARARs for groundwater were exceeded. The risk assessment performed at this site indicated that the contaminated groundwater at the site poses an unacceptable risk to human health.

The extent of soils contamination at the fire training pit was estimated during the 1987 RI and has been summarized briefly in this report. Samples collected contained TPH and volatile organics. During the 1989 soils investigation two additional borings were augered into the suspected fire training pit and samples were collected for metals analyses. In one surface soil sample lead was detected significantly higher than the background level. The soils in this fire training pit are believed to be a continuing source for groundwater contamination.

The majority of soil borings installed during the 1989 investigation concentrated on the suspected areas of a second burn pit and a munitions burn pit. In samples from two borings in the suspected area of the second burn pit and from two borings near the suspected munitions burn pit, TPH was detected at concentrations over 100 mg/kg; volatile organics were not detected in these samples. In addition, low levels of toluene were detected near the suspected second burn pit and lead was detected near the suspected munitions burn pit. Due to the low levels of volatile organics in the soils and absence of contaminants in the downgradient well (MW-10), neither the suspected second burn pit area nor suspected munitions burn pit area are believed to contribute to the groundwater contamination problem. Either burning activities or roadside vehicle maintenance could account for these two areas of relatively minor contamination.

The extent and magnitude of groundwater contamination has been defined using the volatile organics analytical results of the groundwater sampling. At the fire training pit, free product was present in seven wells (WW-1, WW-4, WW-5, WW-6, ET-3, ET-4, and ET-5). The results of a bail-down test indicated that the actual thickness of product on the water table beneath the fire training pit is about 2 inches. The amount of recoverable product was estimated to be between 100 and 550 gallons. Groundwater contamination is moving to the northeast in the direction of regional groundwater flow. Volatile organics were not detected in groundwater samples collected from wells 1,000 feet downgradient.

The compounds detected in soils and groundwater at Site 1, including those detected during the 1988 sampling effort [ES, 1990b], are presented in Table 5.49. This table also provides a comparison of the maximum detected concentrations to ARARs. ARARs exceeded at this site include the Wisconsin Enforcement Standards and Federal MCLs. ARARs for soils were not identified; however, To-Be-Considered criteria for soils are presented in Section 4. Compounds detected in

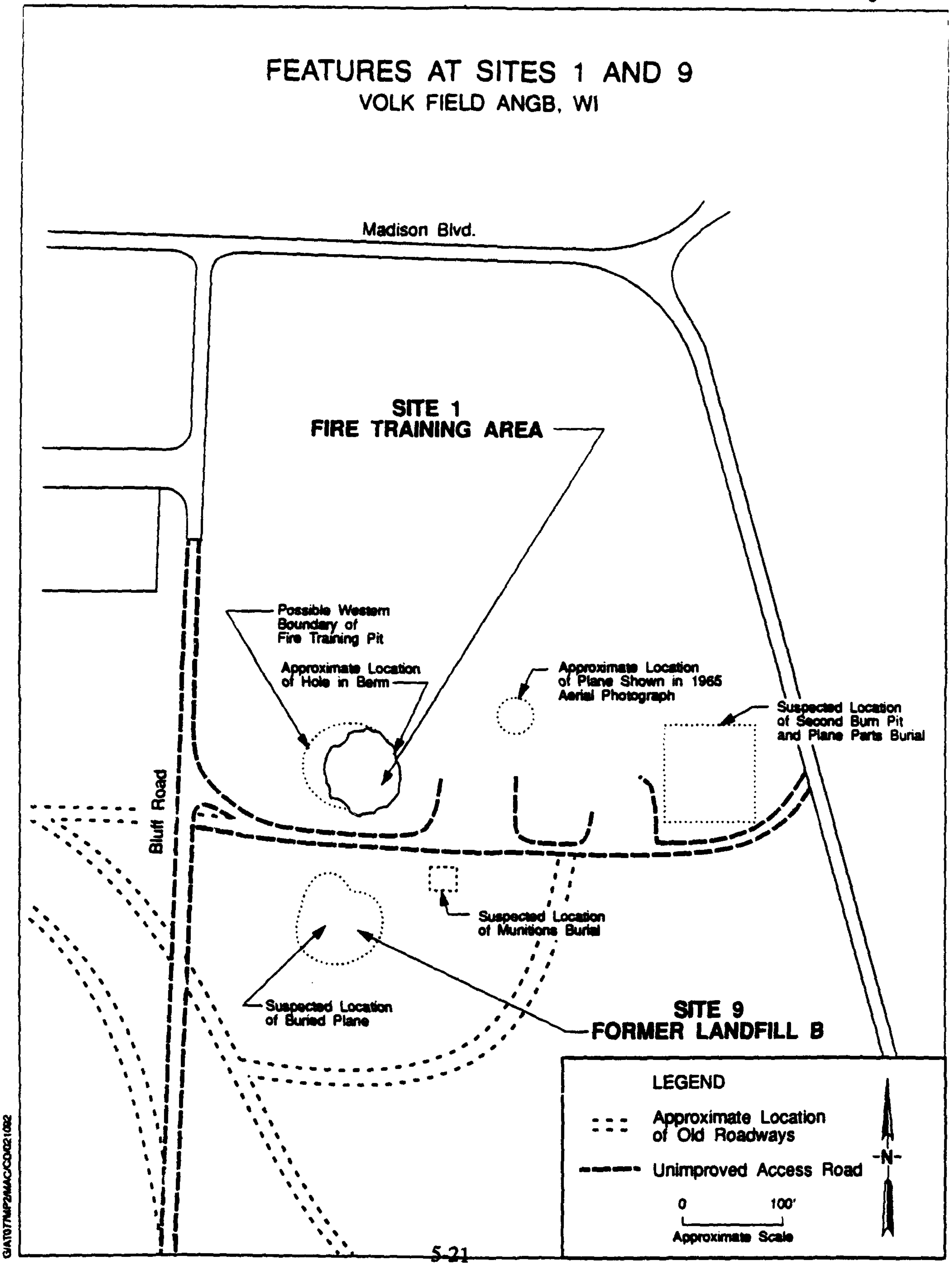
groundwater which exceeded ARARs include benzene, pentachlorophenol, toluene, TCE, xylene, and lead.

The pathways for exposure considered at Site 1 included the incidental ingestion of and dermal contact with surface and deep soils, ingestion of groundwater, dermal contact with groundwater, and inhalation of volatiles from groundwater. The risks associated with the soils (both surface and deep) were found to be acceptable for all receptors. Carcinogenic risks associated with ingestion of groundwater were found to be unacceptable for all receptors due primarily to the presence of benzene, bis(2-ethylhexyl)phthalate, and pentachlorophenol. Unacceptable noncarcinogenic risks associated with ingestion of groundwater were also found for children due primarily to the presence of bis(2-ethylhexyl)phthalate; 1,3-dichloropropene; naphthalene; and toluene. For children and adults, carcinogenic and noncarcinogenic risks associated with inhalation of volatiles from groundwater were found to be unacceptable primarily due to the presence of benzene (carcinogenic) and toluene and xylene (noncarcinogenic). However, the groundwater exposure pathways at this site are for hypothetical (future) residents and are not currently complete. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

RECOMMENDATIONS

In accordance with the National Contingency Plan (NCP), removal actions include appropriate actions that will minimize the migration of hazardous substances into the soil or groundwater. Considering the small amount of free product available for recovery, ES recommended the product at Site 1 be removed periodically by bailing select wells. The recovered product could be containerized in 55 gallon drums. This should be considered an intermediate response until a final remedial alternative is in place. The contamination in the soils at Site 1 is a source of groundwater contamination beneath the site. It is recommended that a FS be conducted to address potential remedial actions for both the soil and groundwater contamination. During the FS and subsequent RD additional information on the site may be required. The collection of contaminated soils may be required to assess characteristics pertinent to the treatment processes under consideration. Extraction and treatment will be considered for groundwater remediation; therefore, additional aquifer testing may be required.

Figure 5.1



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SITE 1, FIRE TRAINING AREA

GROUNDWATER CONTOUR MAP, 13 NOVEMBER 1990

VOLK FIELD ANGB, WI

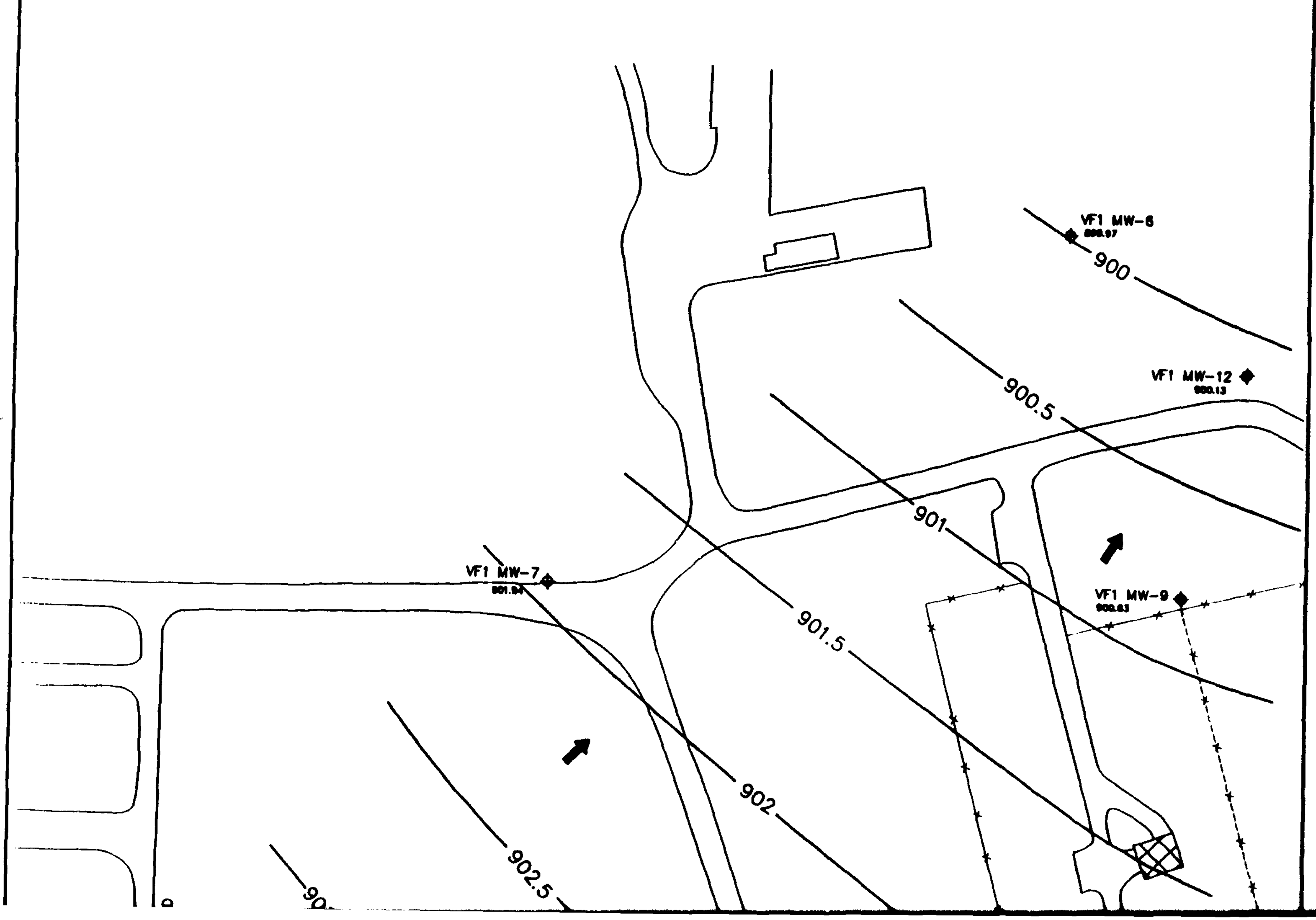
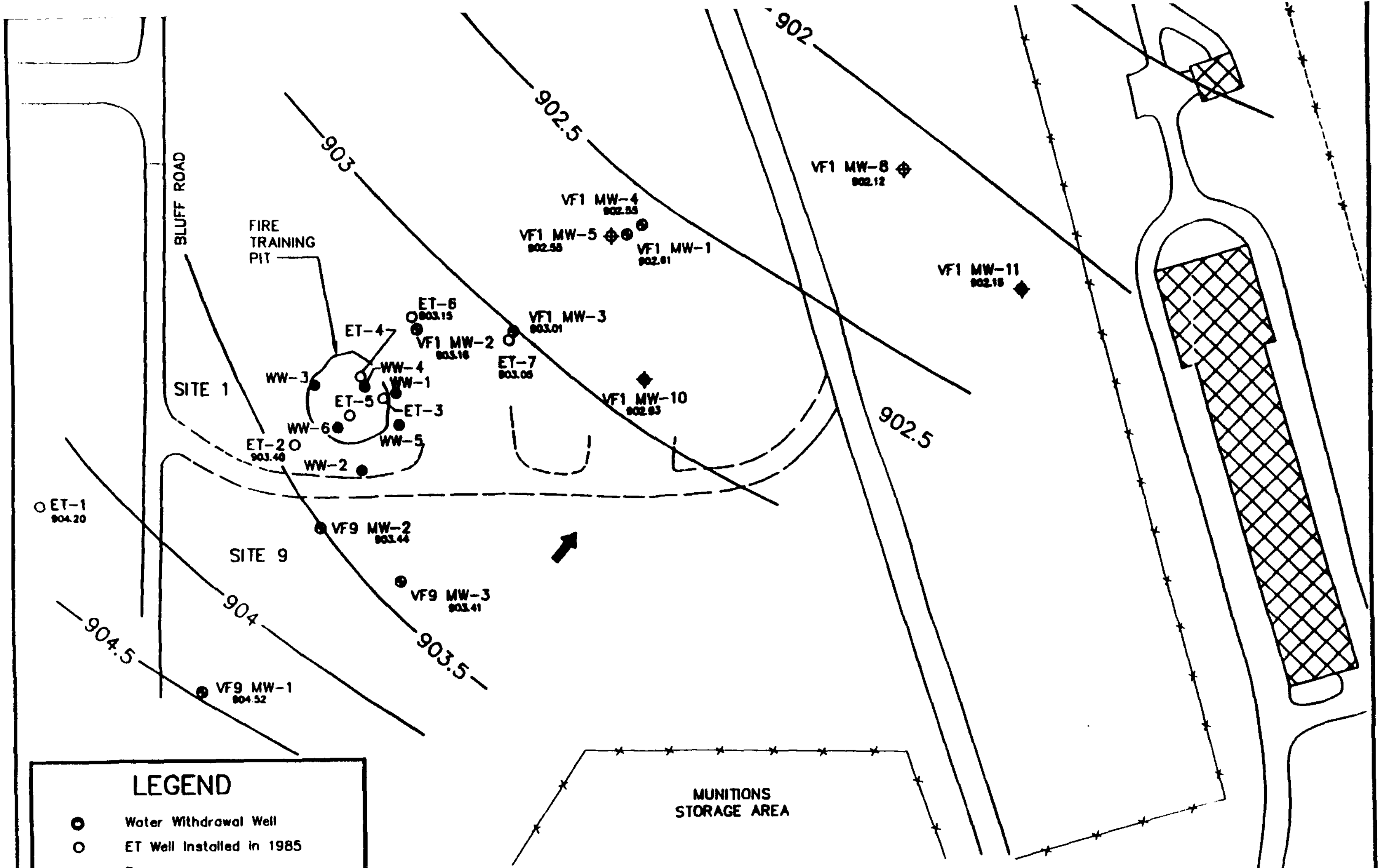
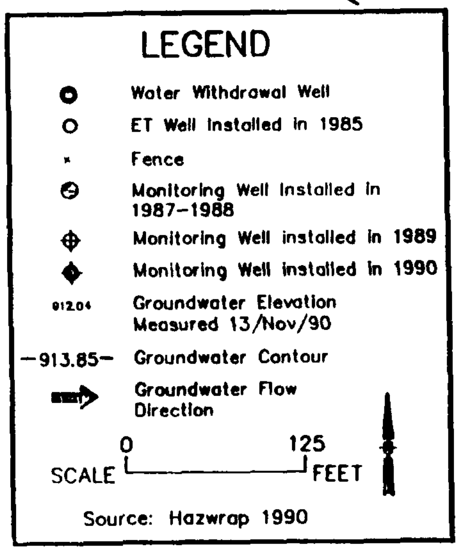


Figure 5.2





WELL I.D.	GROUNDWATER ELEVATION (ABOVE MSL)	WELL I.D.	GROUNDWATER ELEVATION (ABOVE MSL)	WELL I.D.	GROUNDWATER ELEVATION (ABOVE MSL)
VF1 MW-1	902.61	VF1 MW-9	900.83	ET-7	903.05
VF1 MW-2	903.16	VF1 MW-10	902.93	VF9 MW-1	904.52
VF1 MW-3	903.01	VF1 MW-11	902.15	VF9 MW-2	903.44
VF1 MW-4	902.55	VF1 MW-12	900.13	VF9 MW-3	903.41
VF1 MW-5	902.55	ET-1	904.20	WW-2	903.36
VF1 MW-6	899.97	ET-2	903.40	WW-3	903.31
VF1 MW-7	901.94	ET-4	903.24	WW-4	903.24
VF1 MW-8	902.12	ET-6	903.15	WW-5	903.22

Figure 5.3

SITE 1, FIRE TRAINING AREA
SOIL GAS SURVEY LOCATIONS AND DETECTIONS
VOLK FIELD ANGB, WI

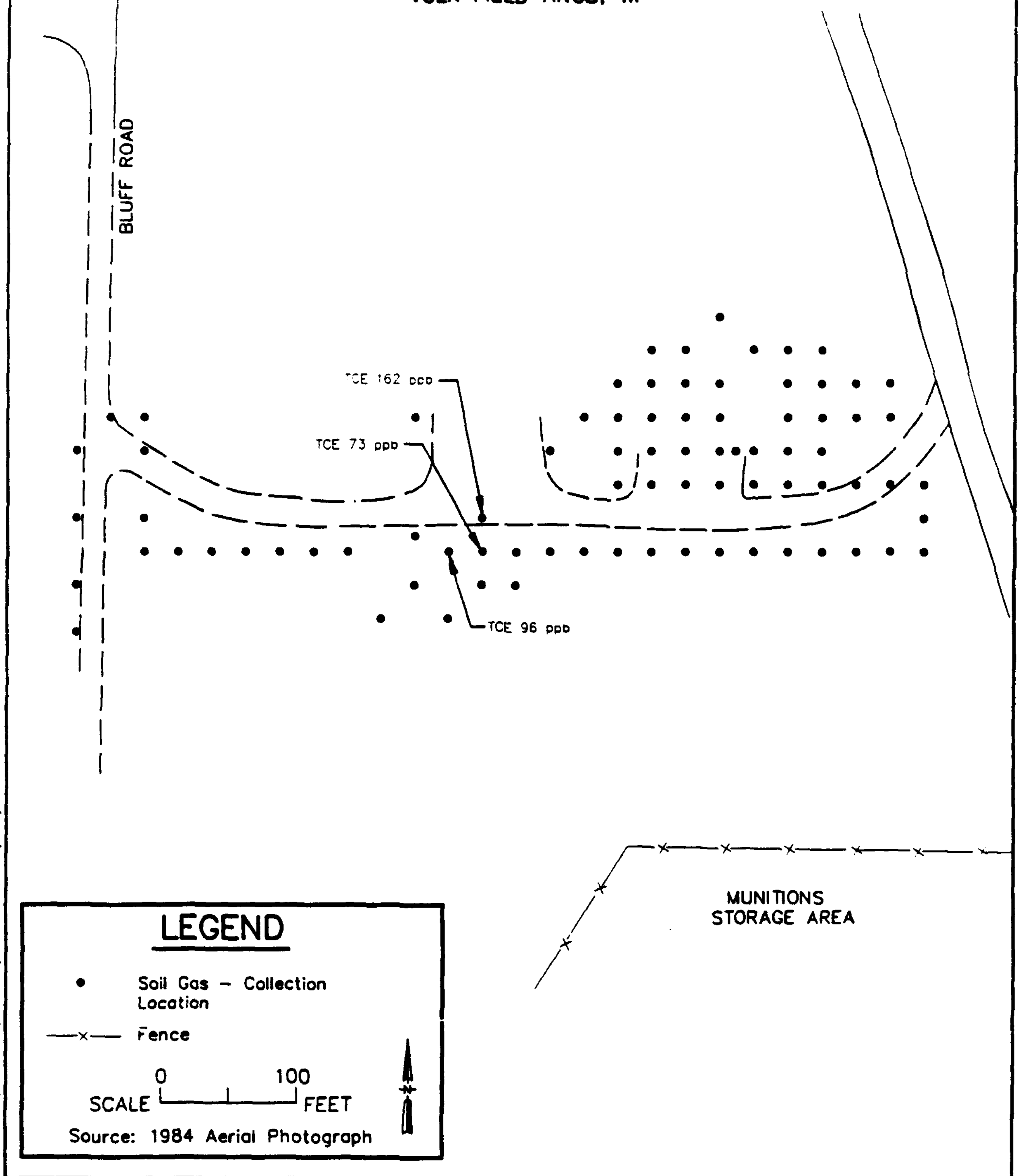


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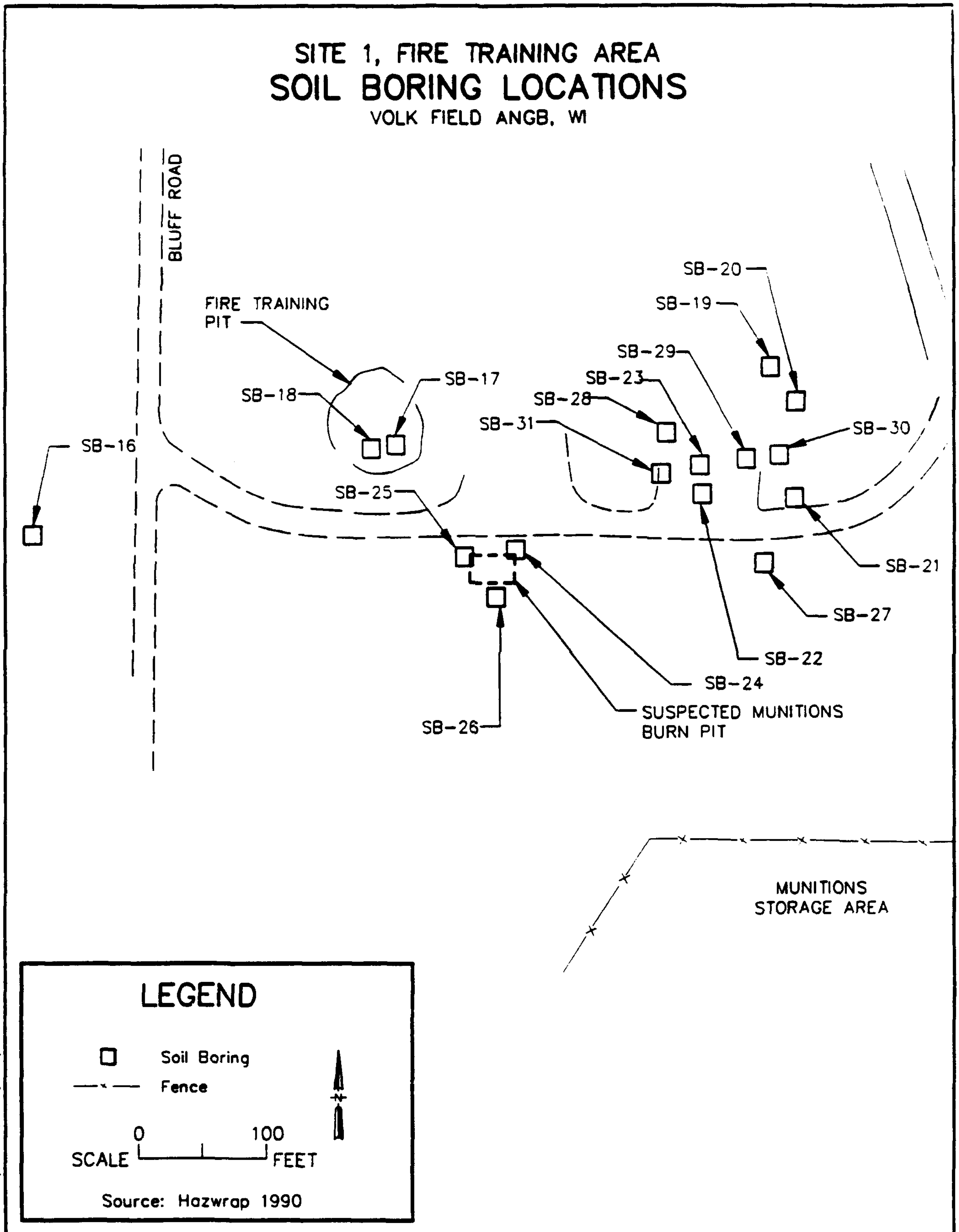
Figure 5.4



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ES ENGINEERING-SCIENCE

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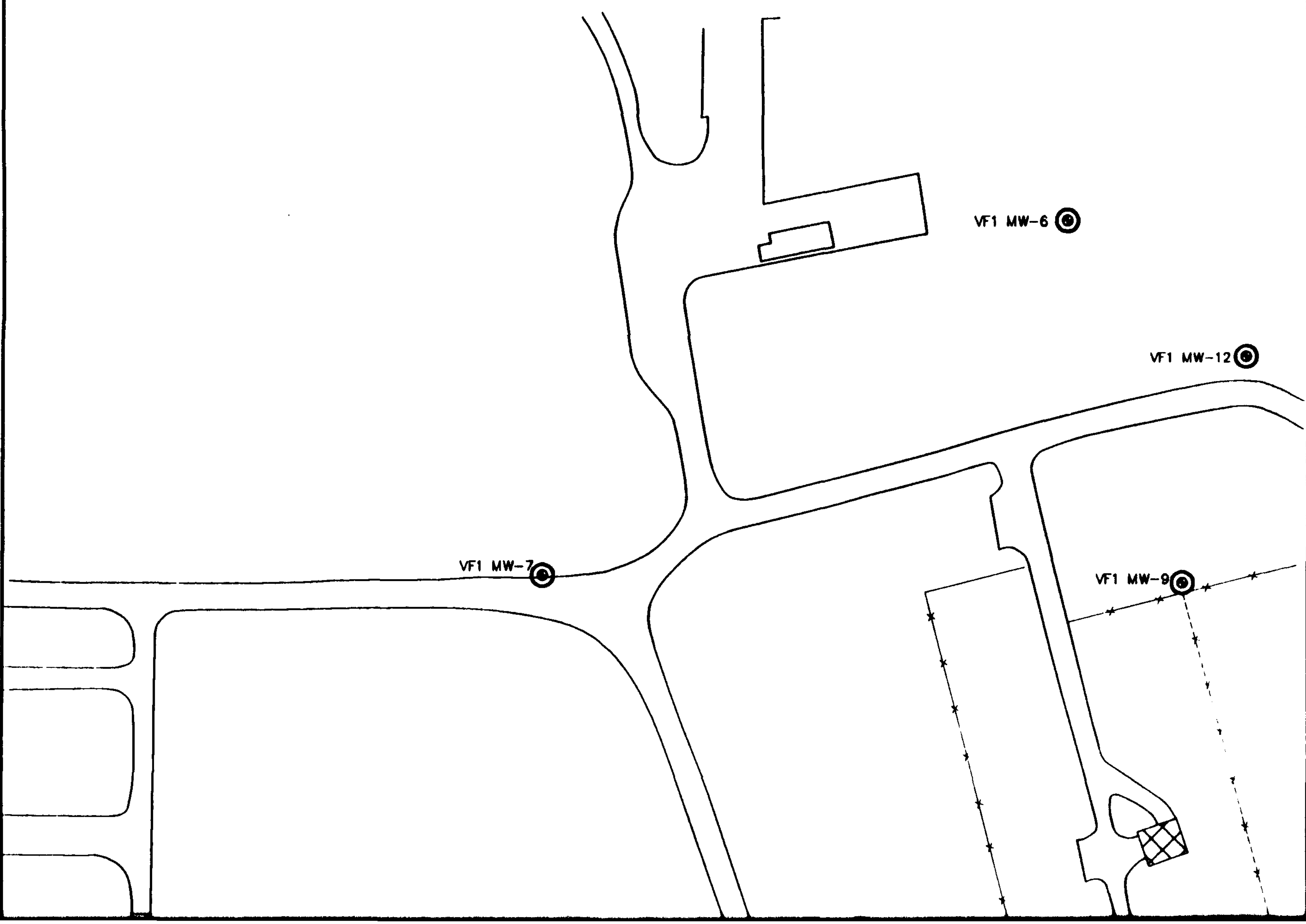
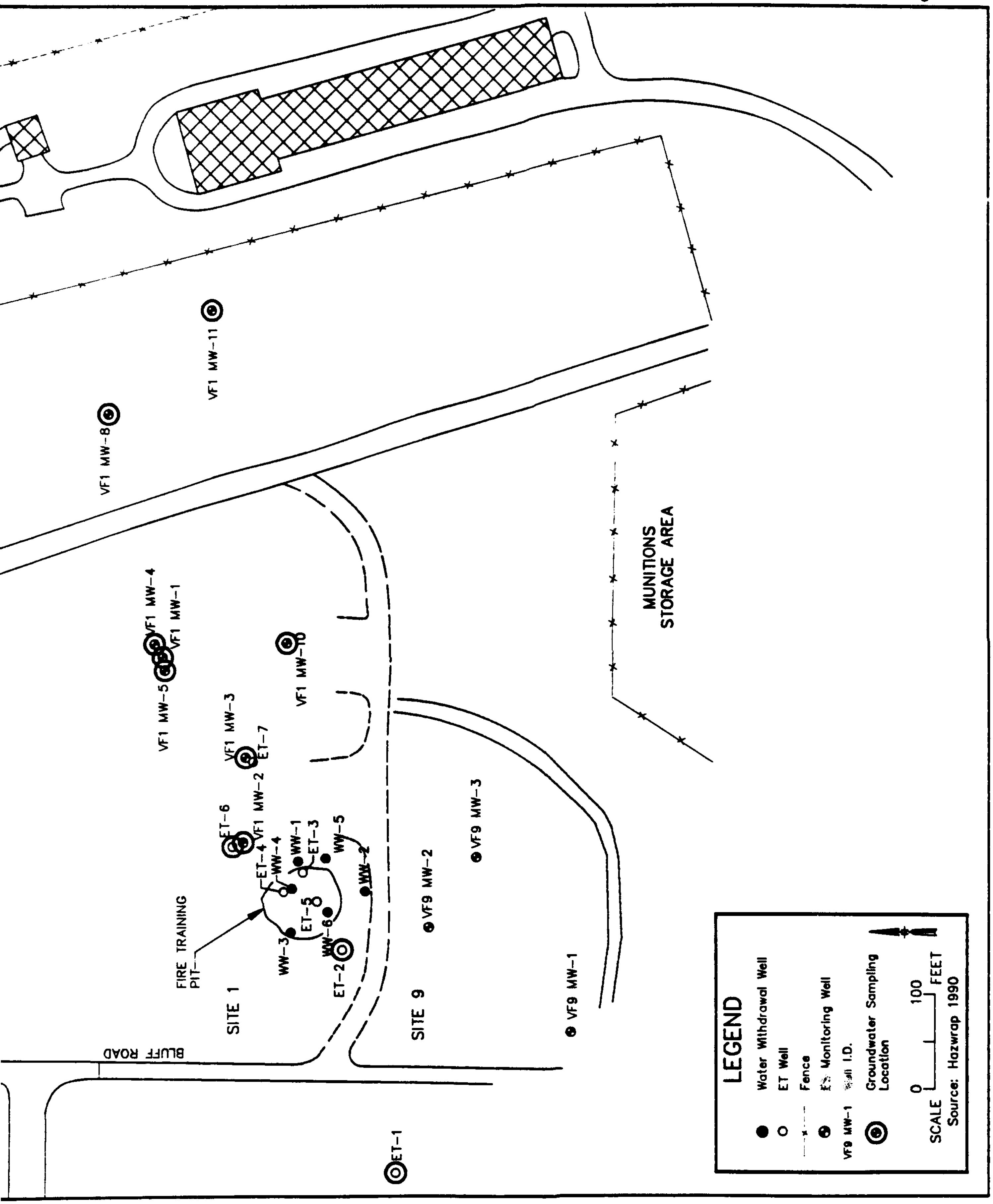
SITE 1, FIRE TRAINING AREA
GROUNDWATER SAMPLING LOCATIONS
VOLK FIELD ANGB, WI





ENGINEERING-SCIENCE

SITE 1, FIRE TRAINING AREA
HYDROGEOLOGIC CROSS–SECTION LOCATION
VOLK FIELD ANGB, WI

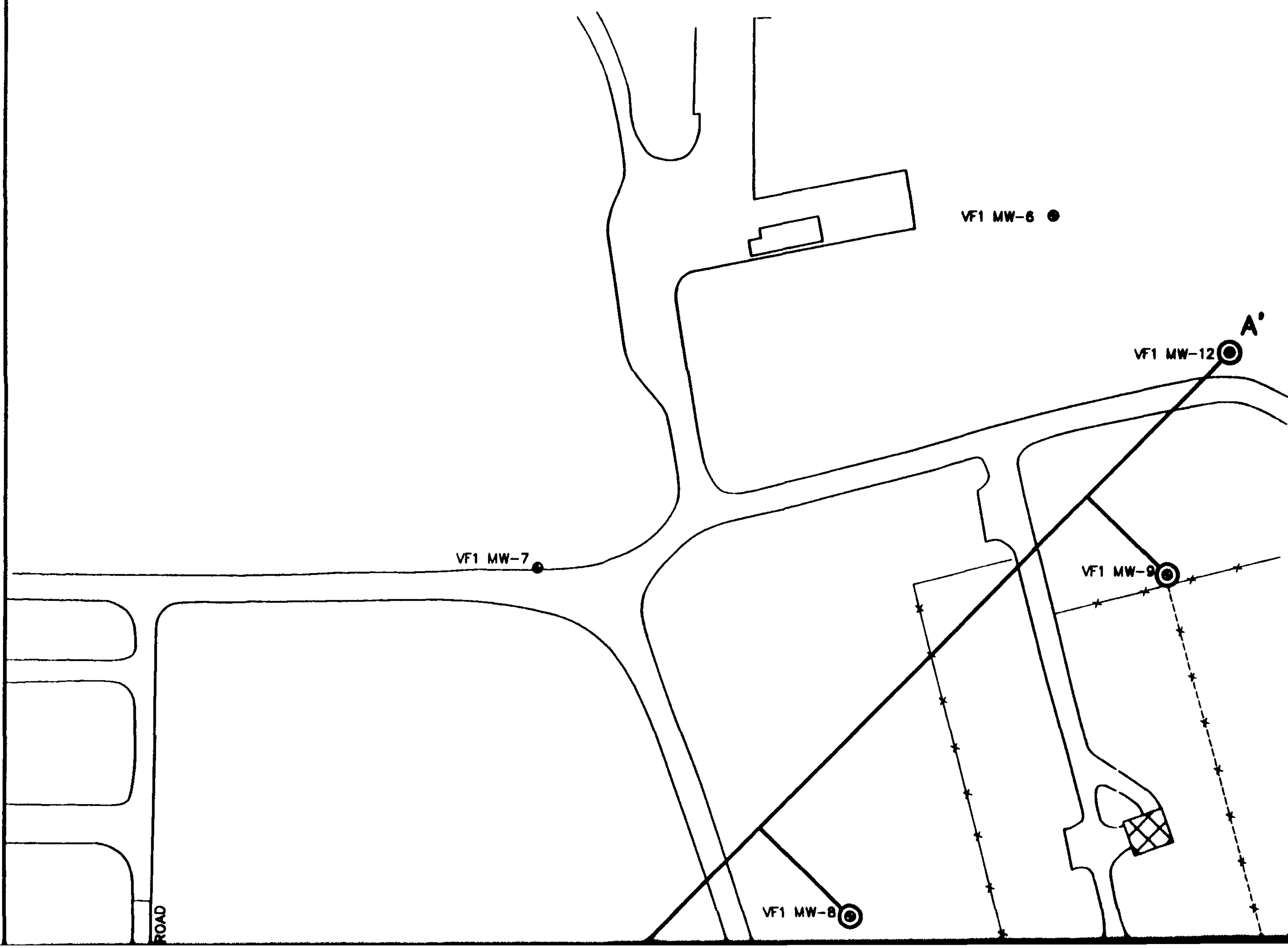
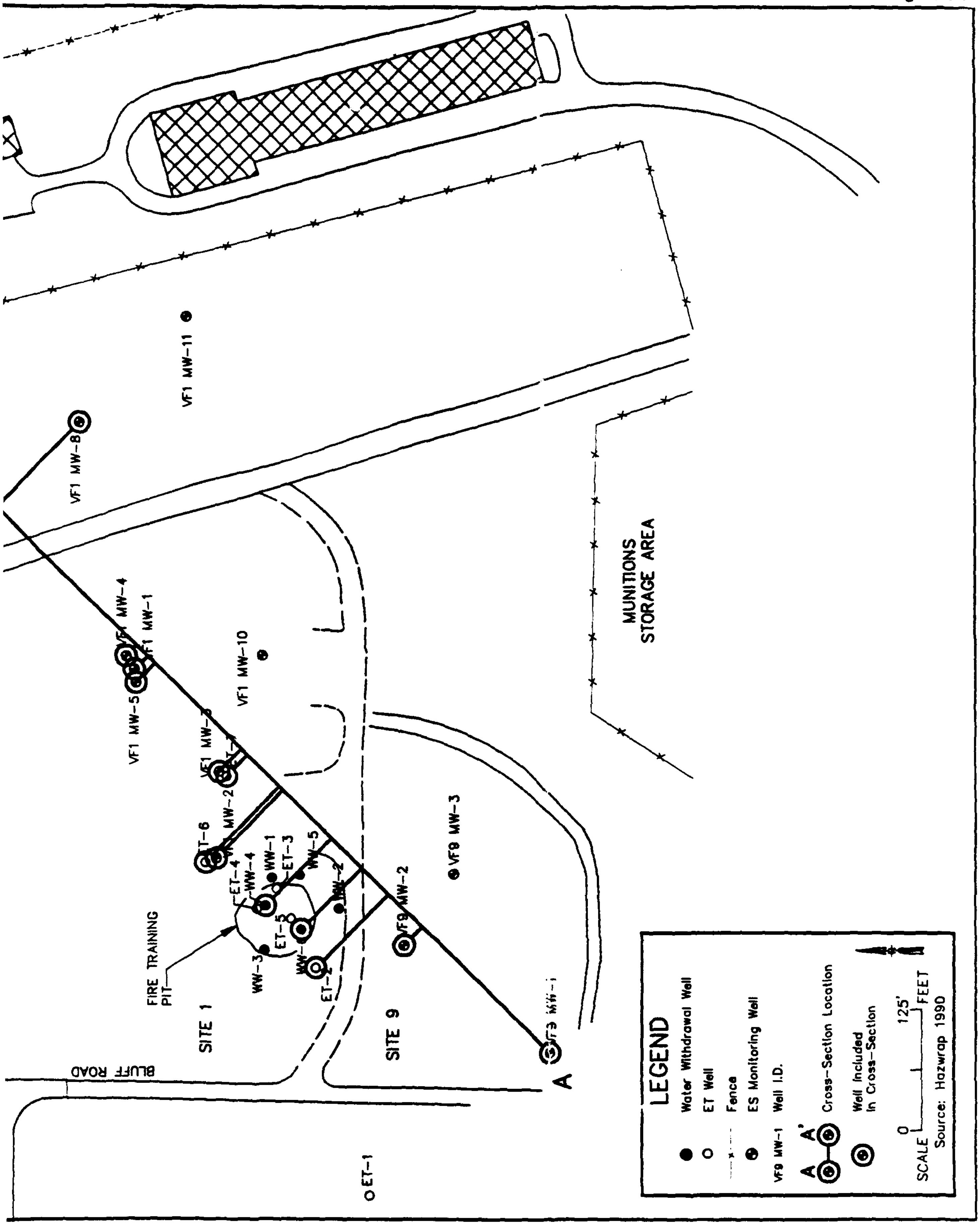


Figure 5.6



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SITE 1, FIRE TRAIN
HYDROGEOLOGIC CROSS
VOLK FIELD ANG

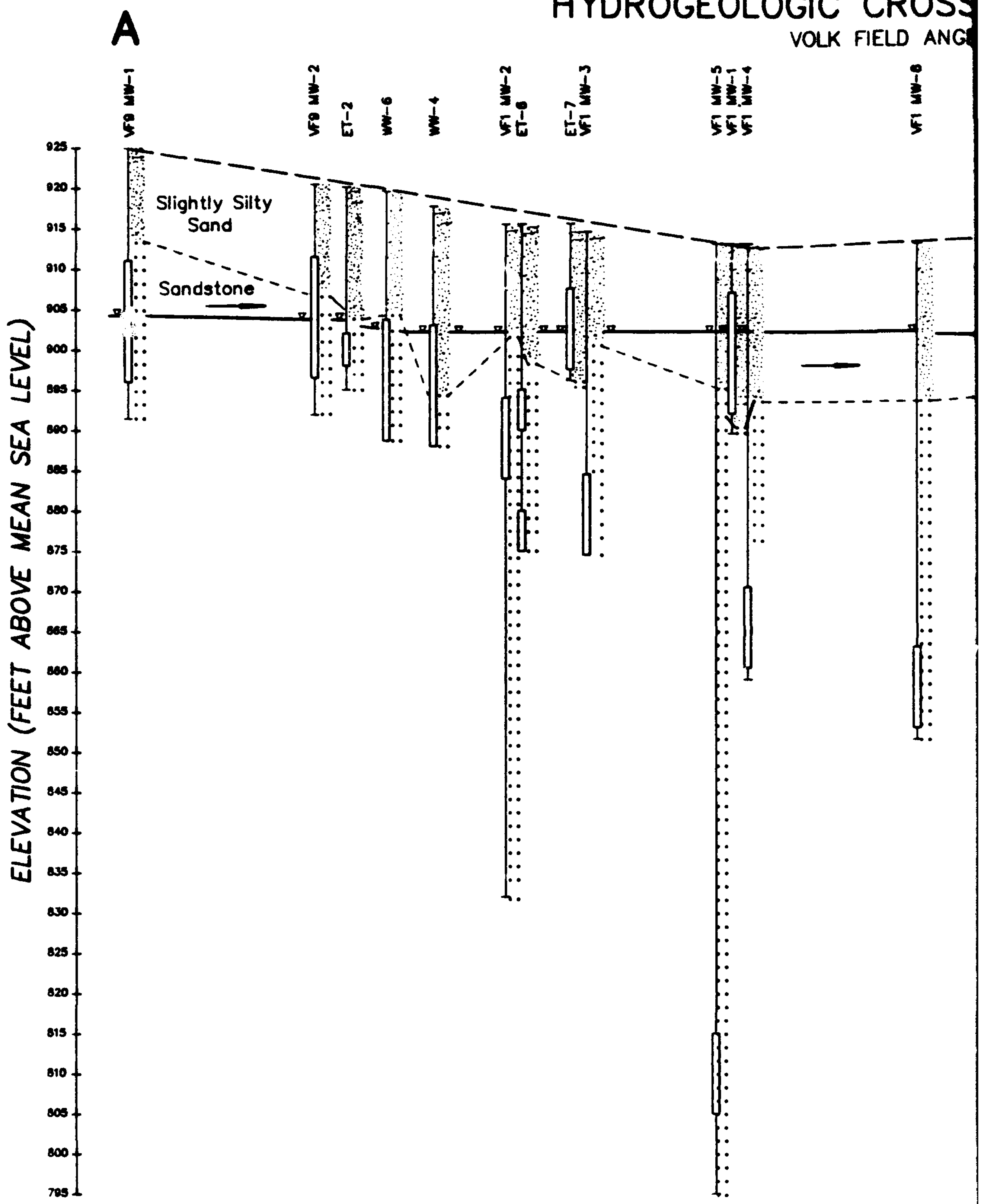

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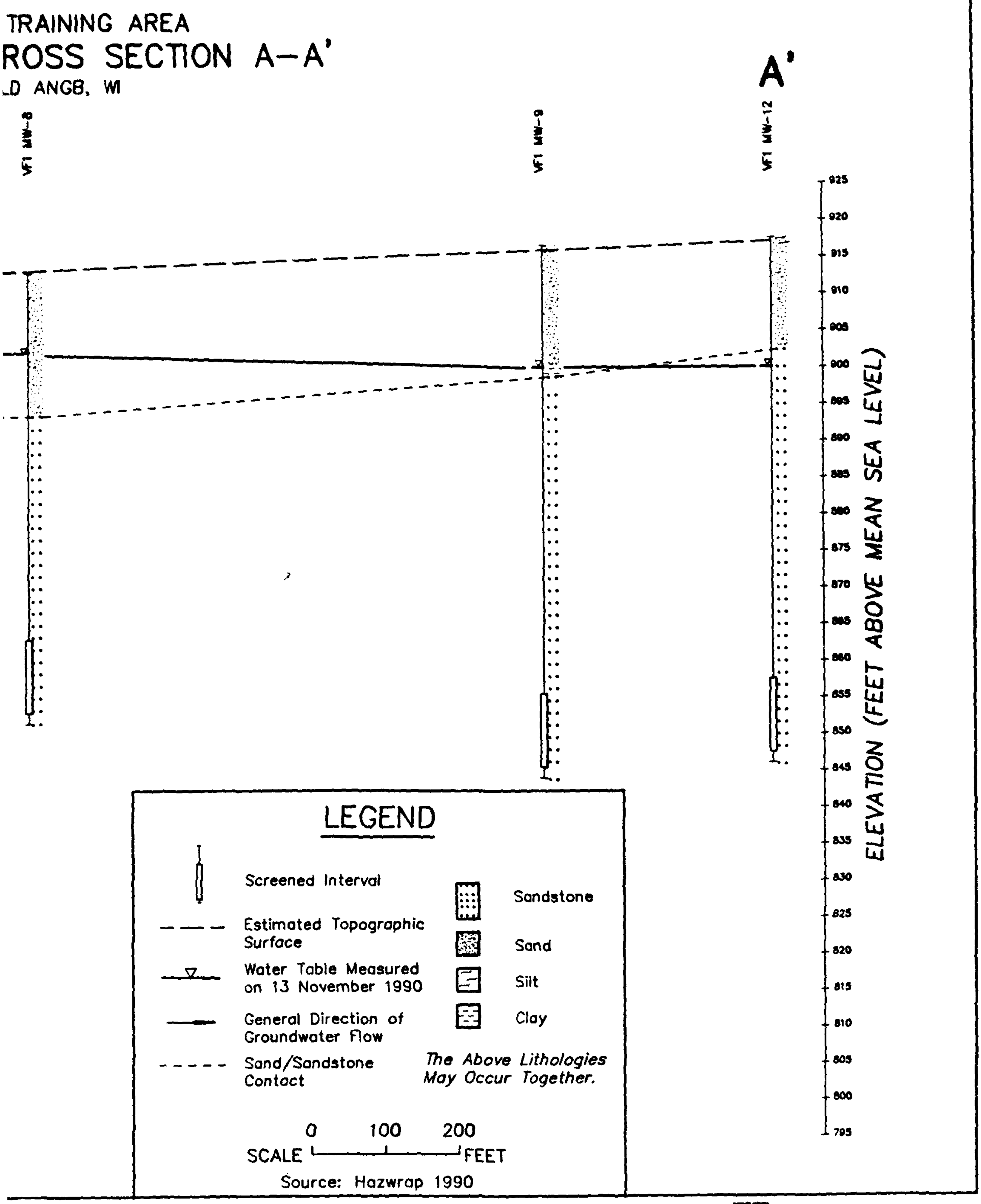
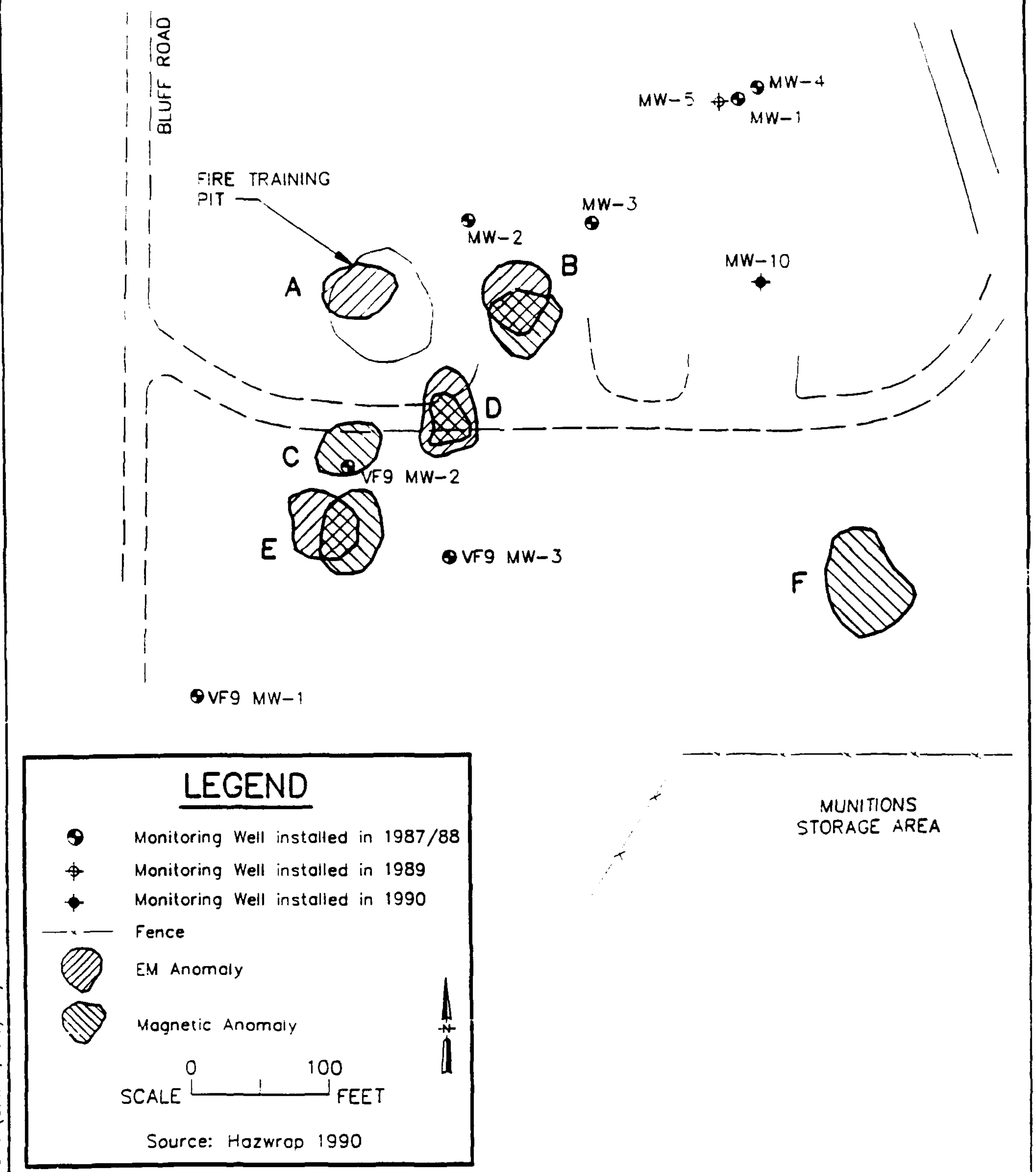
Figure 5.7



ES ENGINEERING-SCIENCE

Figure 5.8

SITE 1, FIRE TRAINING AREA
GEOPHYSICAL ANOMALY OUTLINE MAP
VOLK FIELD ANGB, WI



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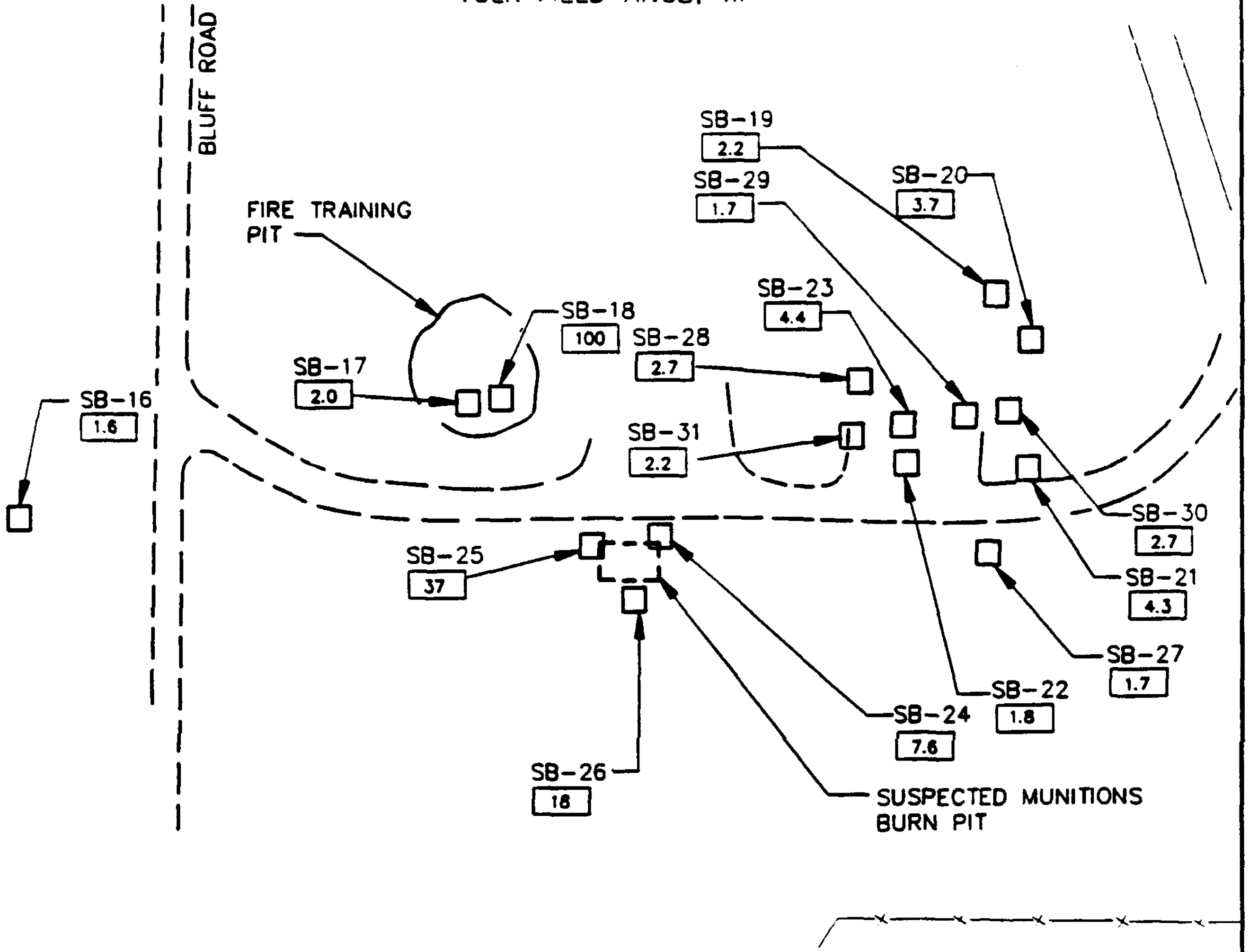
ES ENGINEERING-SCIENCE

SITE 1, FIRE TRAINING AREA
TOTAL LEAD IN SURFACE SOILS
VOLK FIELD ANGB, WI



TOTAL LEAD, 4-8 FEET	
BORING	(mg/kg)
SB-17	0.7
SB-18	12
SB-19	2.7
SB-20	0.9
SB-21	1.3
SB-22	1.2
SB-23	2.0
SB-24	3.3
SB-25	15
SB-26	4.2
SB-27	1.2
SB-28	1.5
SB-29	0.8
SB-30	1.7
SB-31	0.8

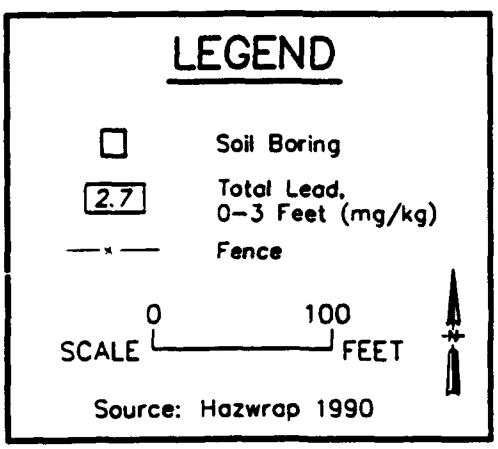


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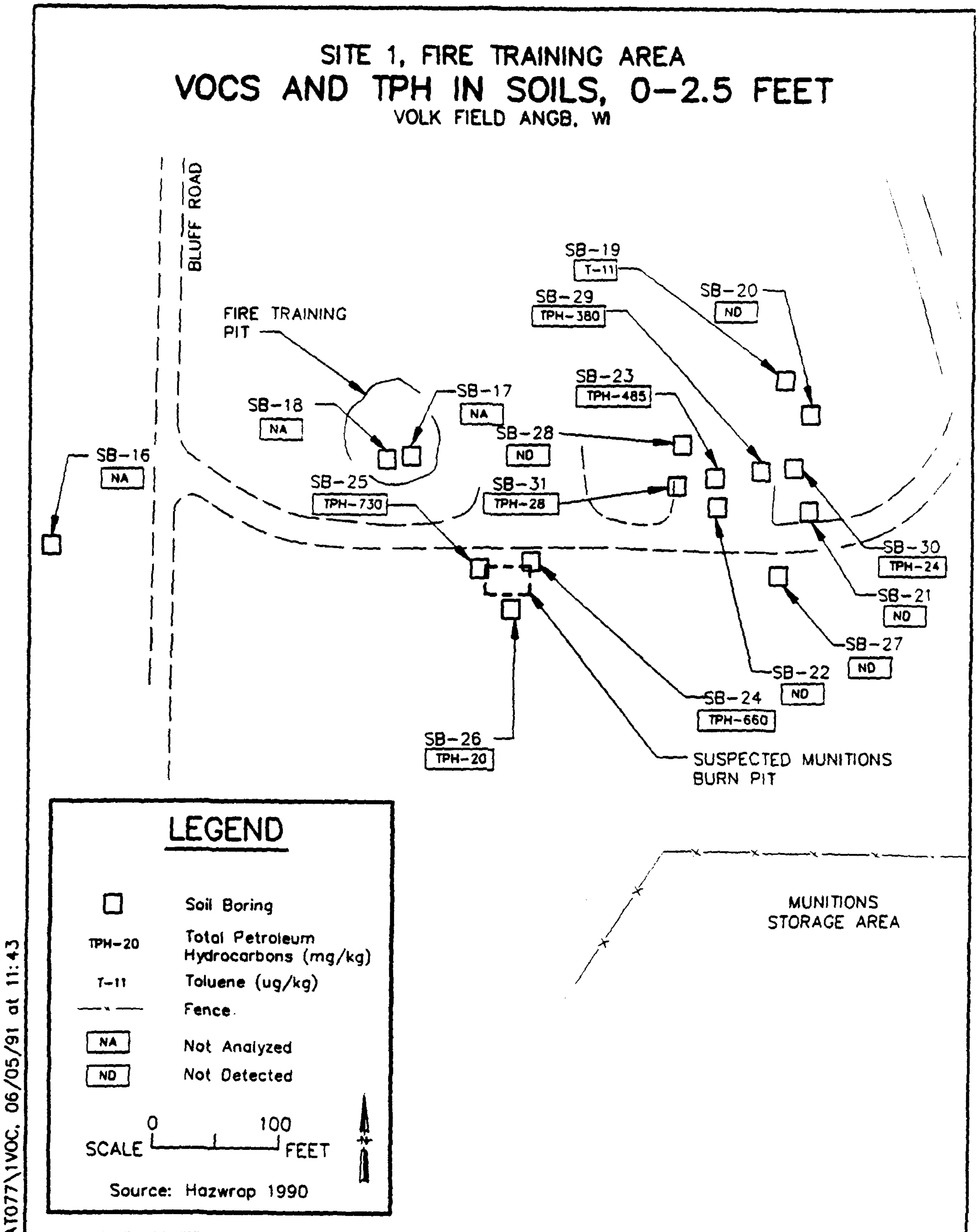
Figure 5.10



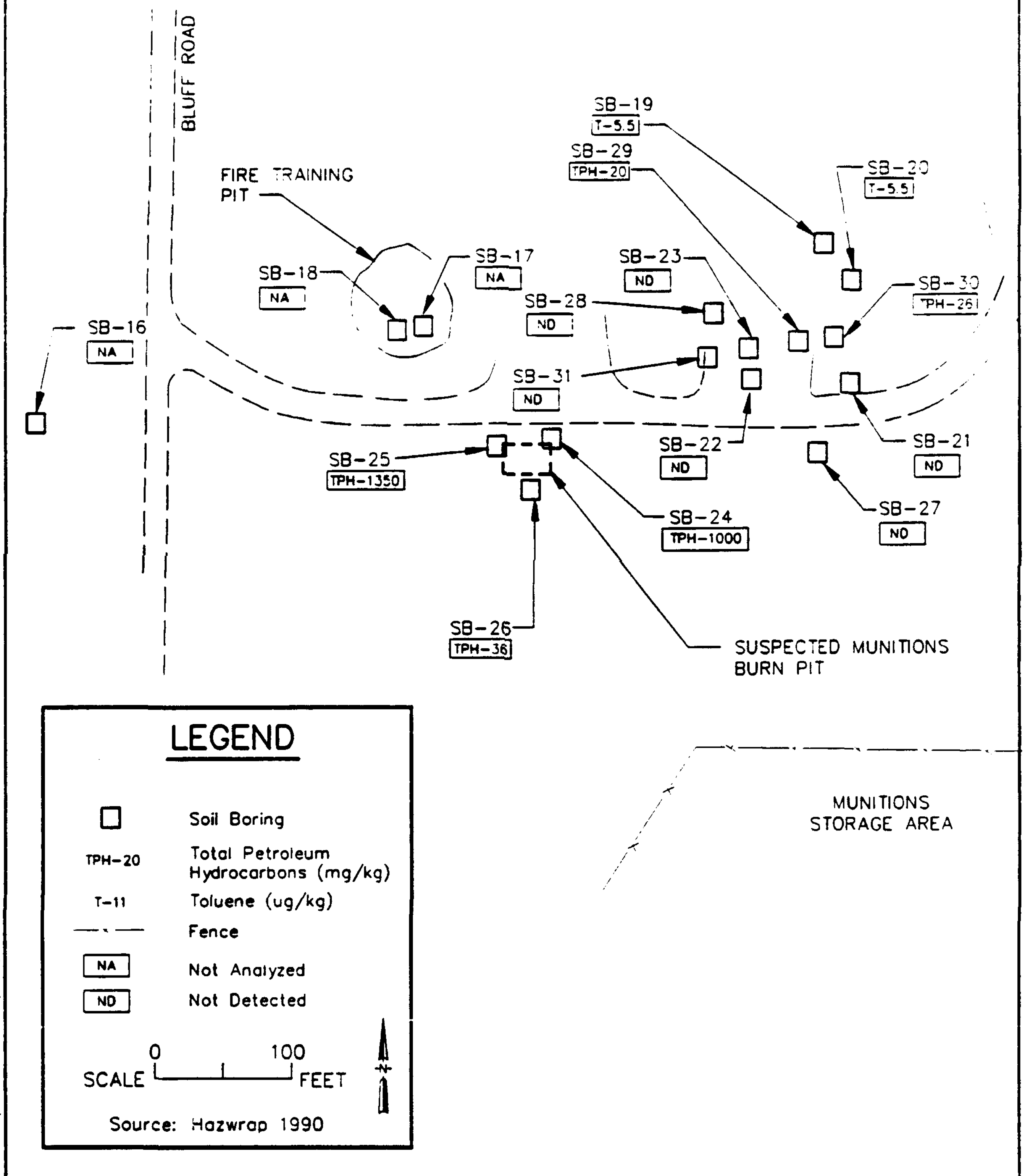
ENGINEERING–SCIENCE

Figure 5.11

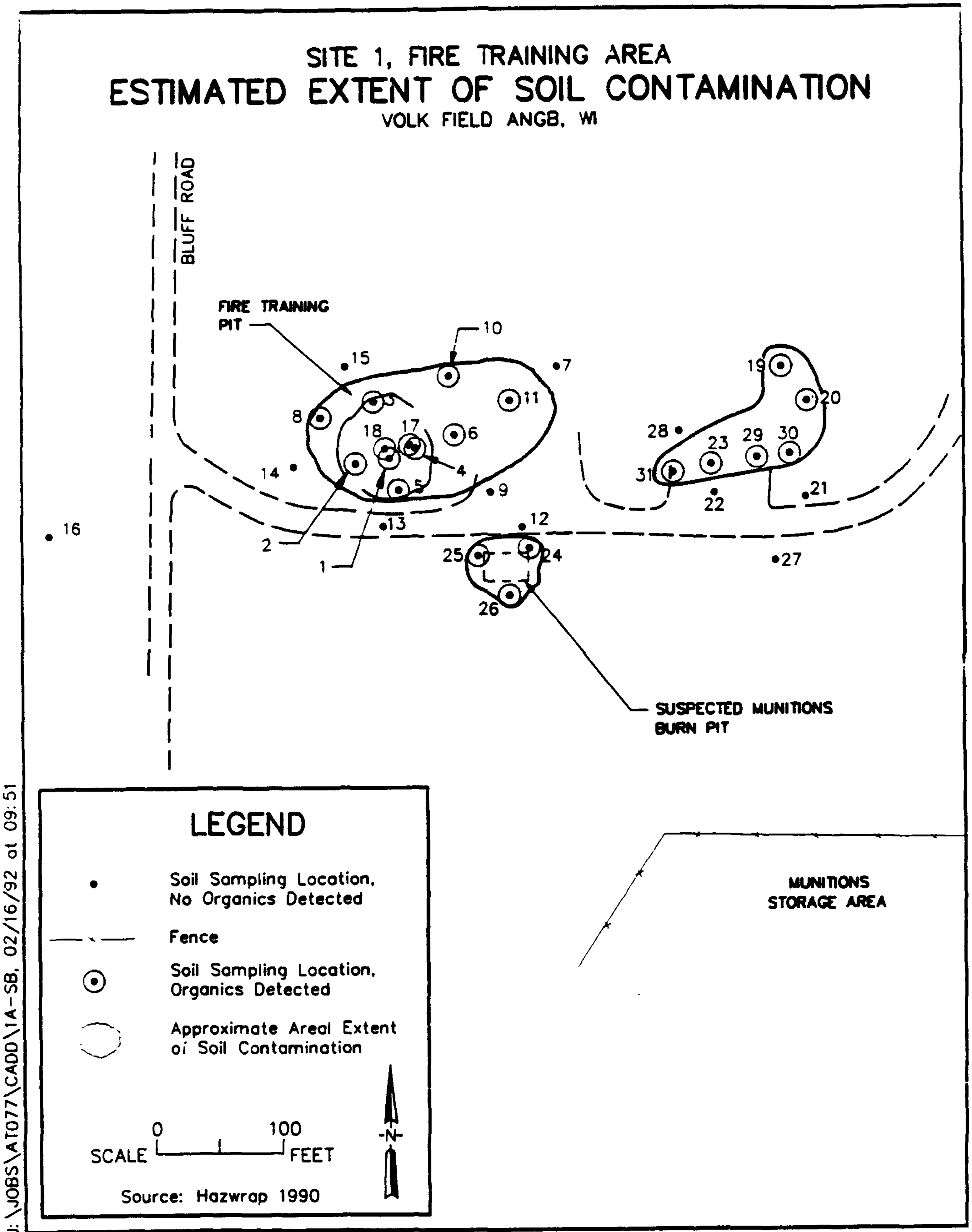
SITE 1, FIRE TRAINING AREA

VOCS AND TPH IN SOILS, 5.5–8.0 FEET

VOLK FIELD ANGB, WI



AT077\1VOC-A, 06/05/91 at 11:53


SITE 1, FIRE TRAINING AREA
ESTIMATED EXTENT OF SOIL CONTAMINATION
VOLK FIELD ANGB, WI
BLUFF ROAD
FIRE TRAINING PIT
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
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26
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28
29
30
31
SUSPECTED MUNITIONS BURN PIT
MUNITIONS STORAGE AREA
LEGEND
Soil Sampling Location, No Organics Detected
Fence
Soil Sampling Location, Organics Detected
Approximate Areal Extent of Soil Contamination
SCALE 0 100 FEET
N
Source: Hazwrap 1990
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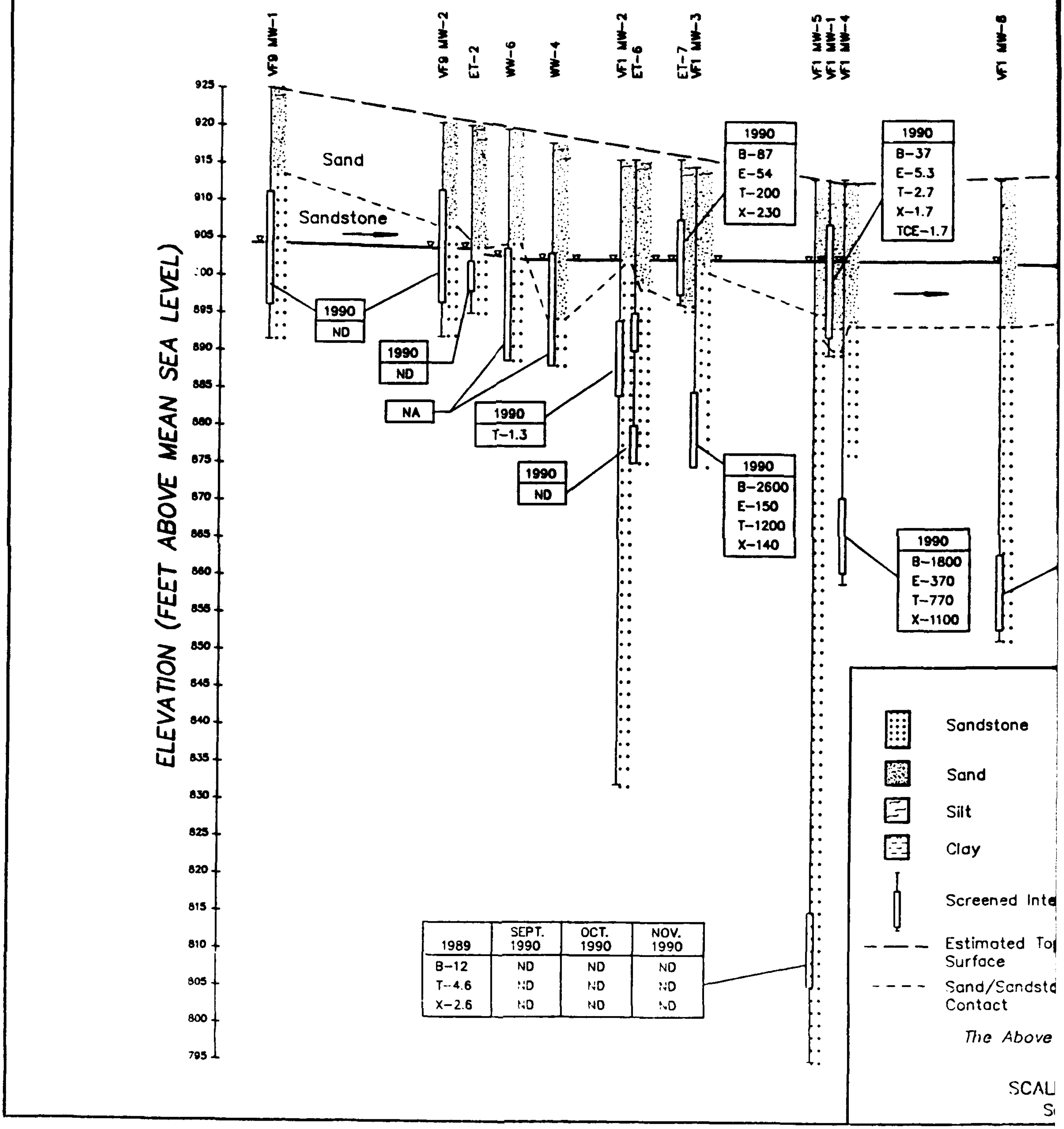
SITE 1, FIRE TRAIN
VOLATILE ORGANICS DETECTED IN
VOLK FIELD ANGE



1989	SEPT. 1990	OCT. 1990	NOV. 1990
B-12	ND	ND	ND
T-4.6	ND	ND	ND
X-2.6	ND	ND	ND

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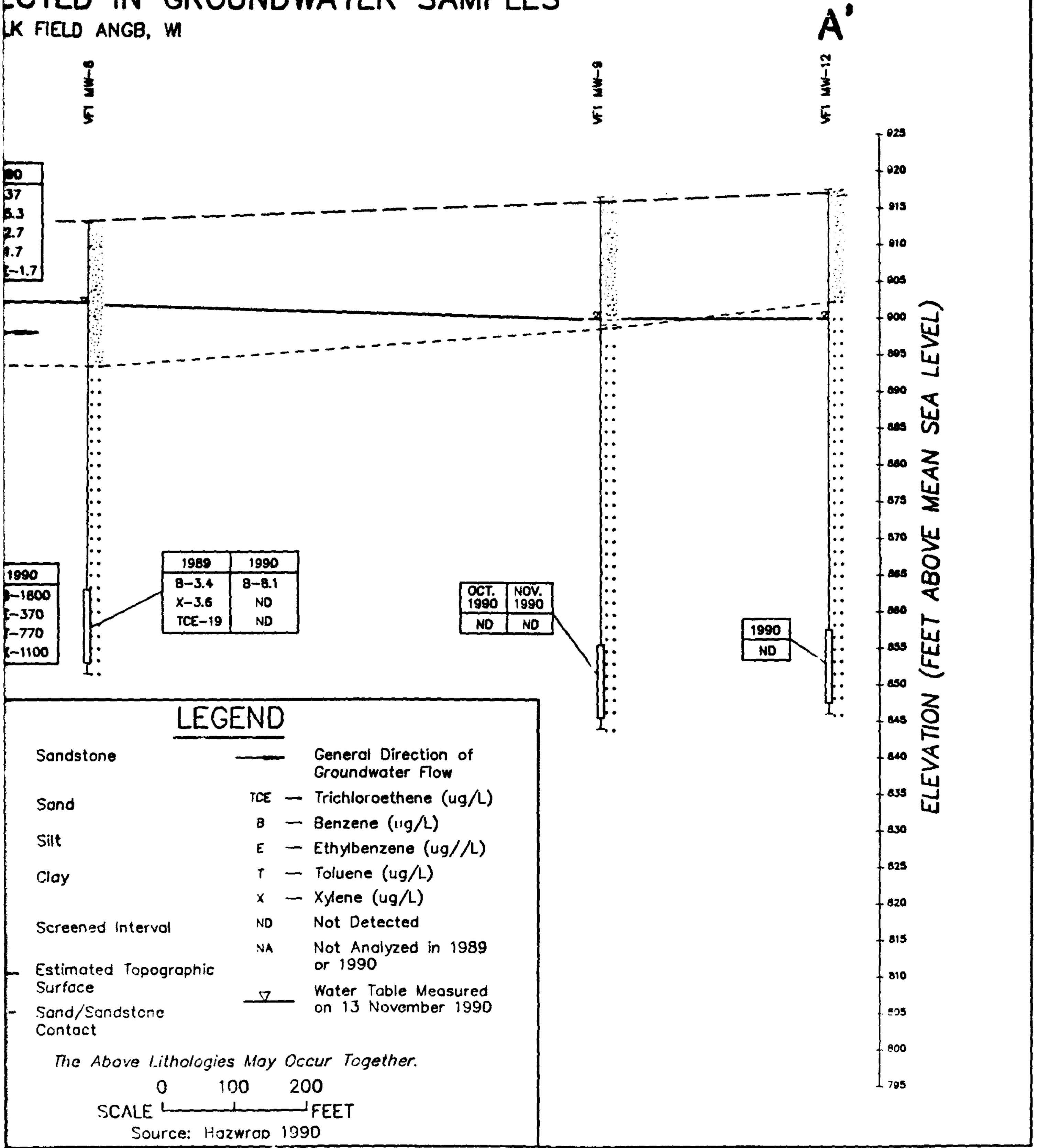
Figure 5.13

FIRE TRAINING AREA
ECTED IN GROUNDWATER SAMPLES
LK FIELD ANGB, WI



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SITE 1, FIRE TRAINING AREA
VOLATILE ORGANICS DETECTED IN GROUNDWATER SAMPLES
VOLK FIELD ANGB, WI

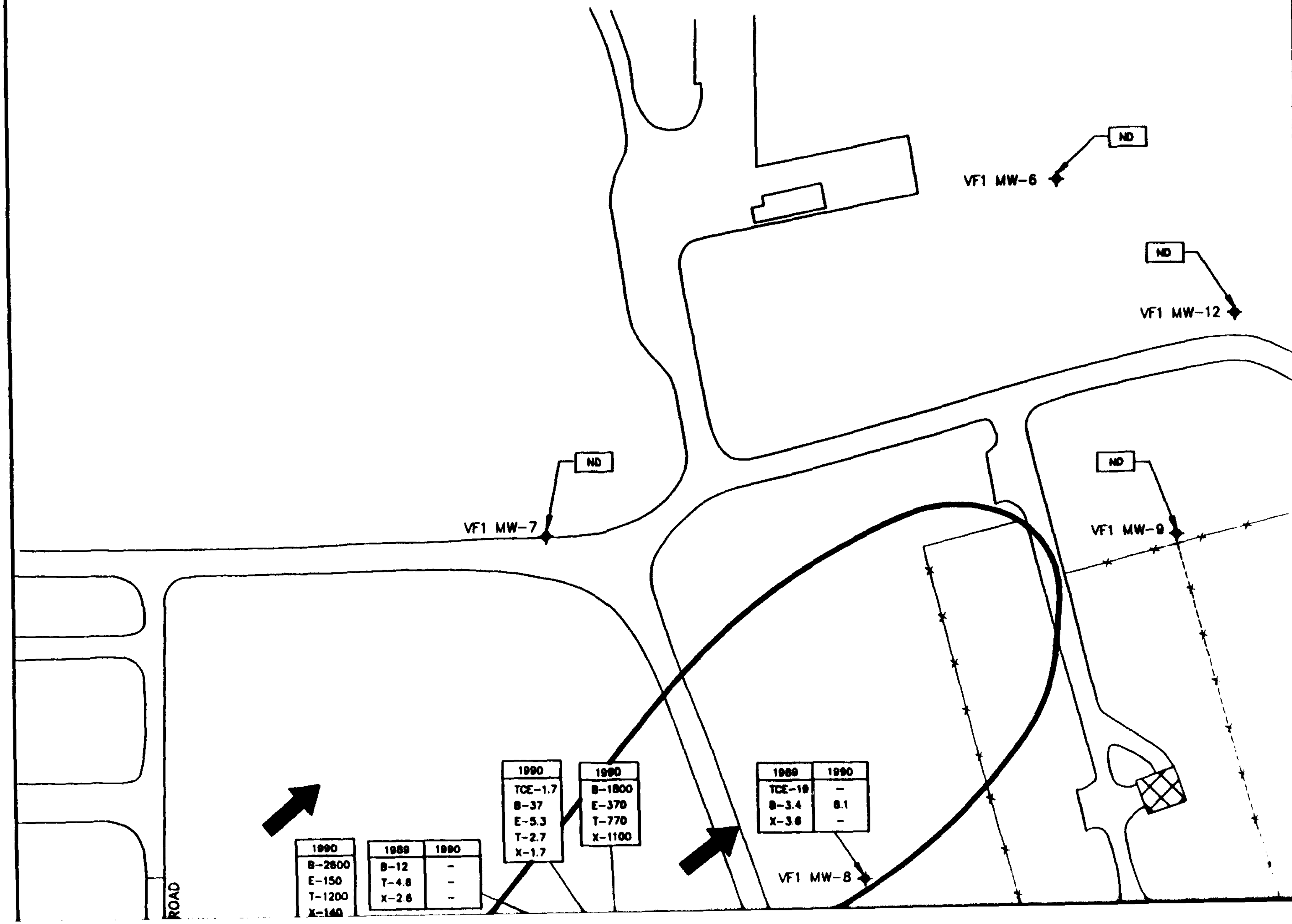
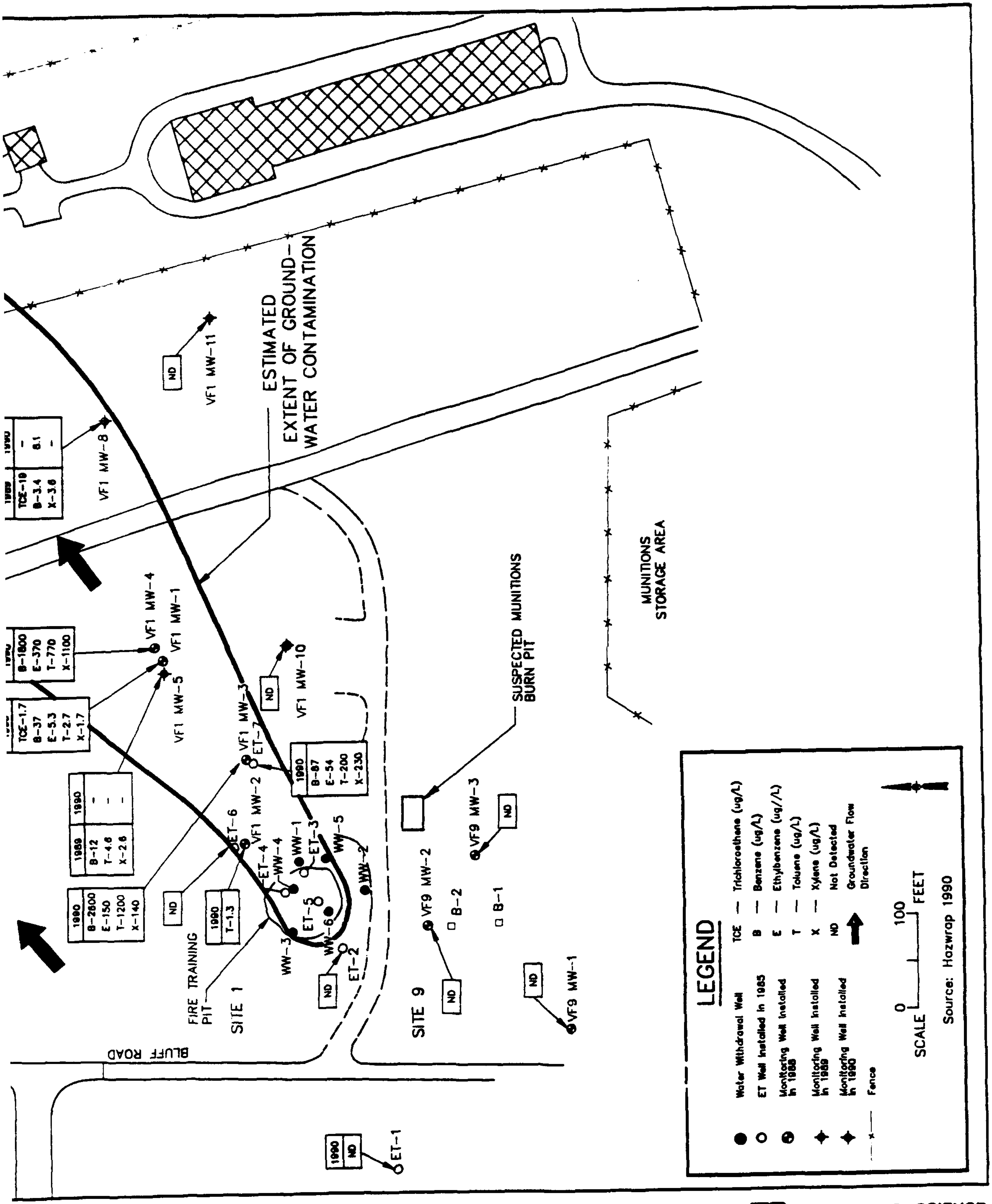


Figure 5.14



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SITE 1, FIRE TRAINING AREA
SEMIVOLATILE ORGANICS DETECTED IN GROUNDWATER SAMPLES
VOLK FIELD ANGB, WI

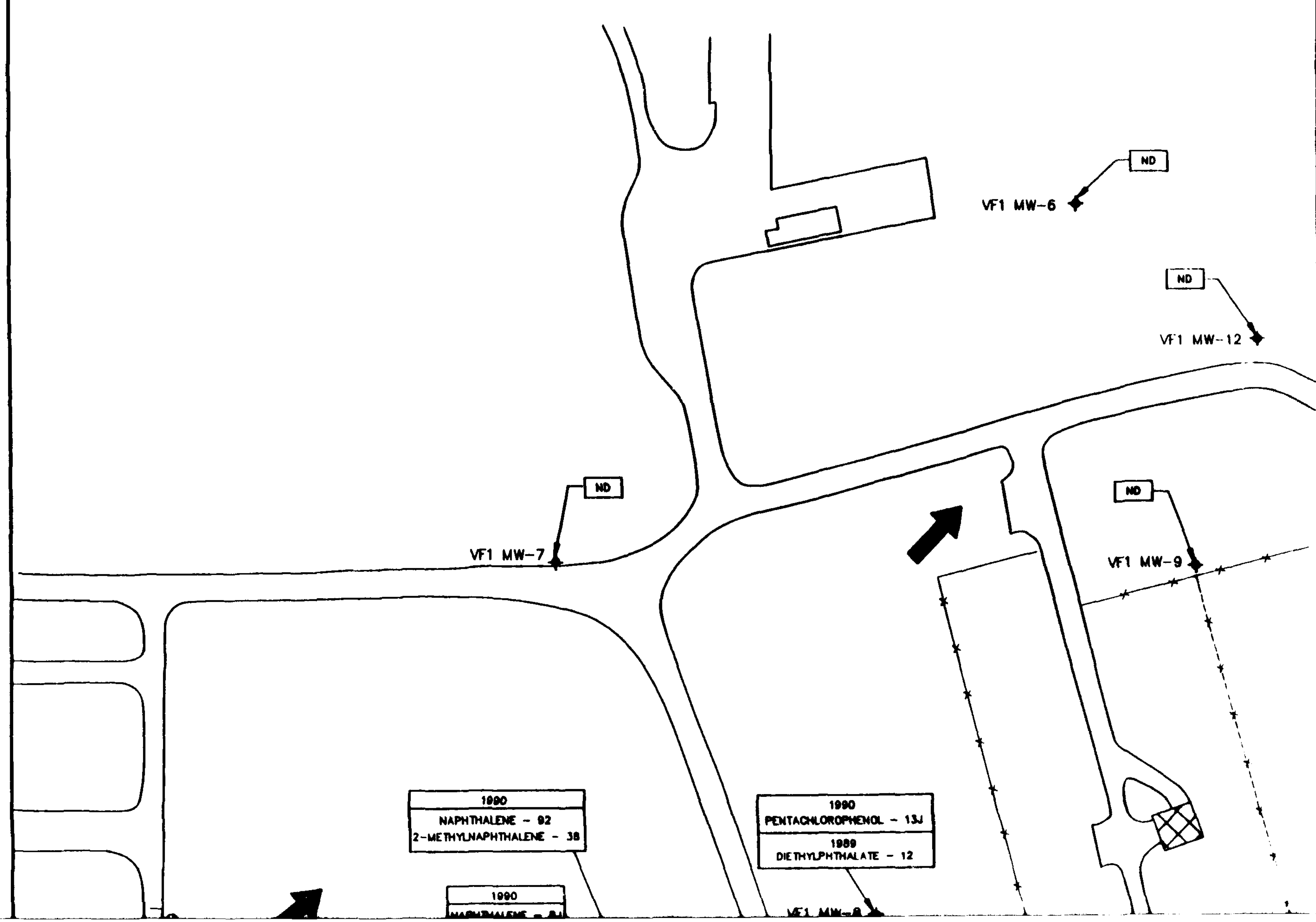
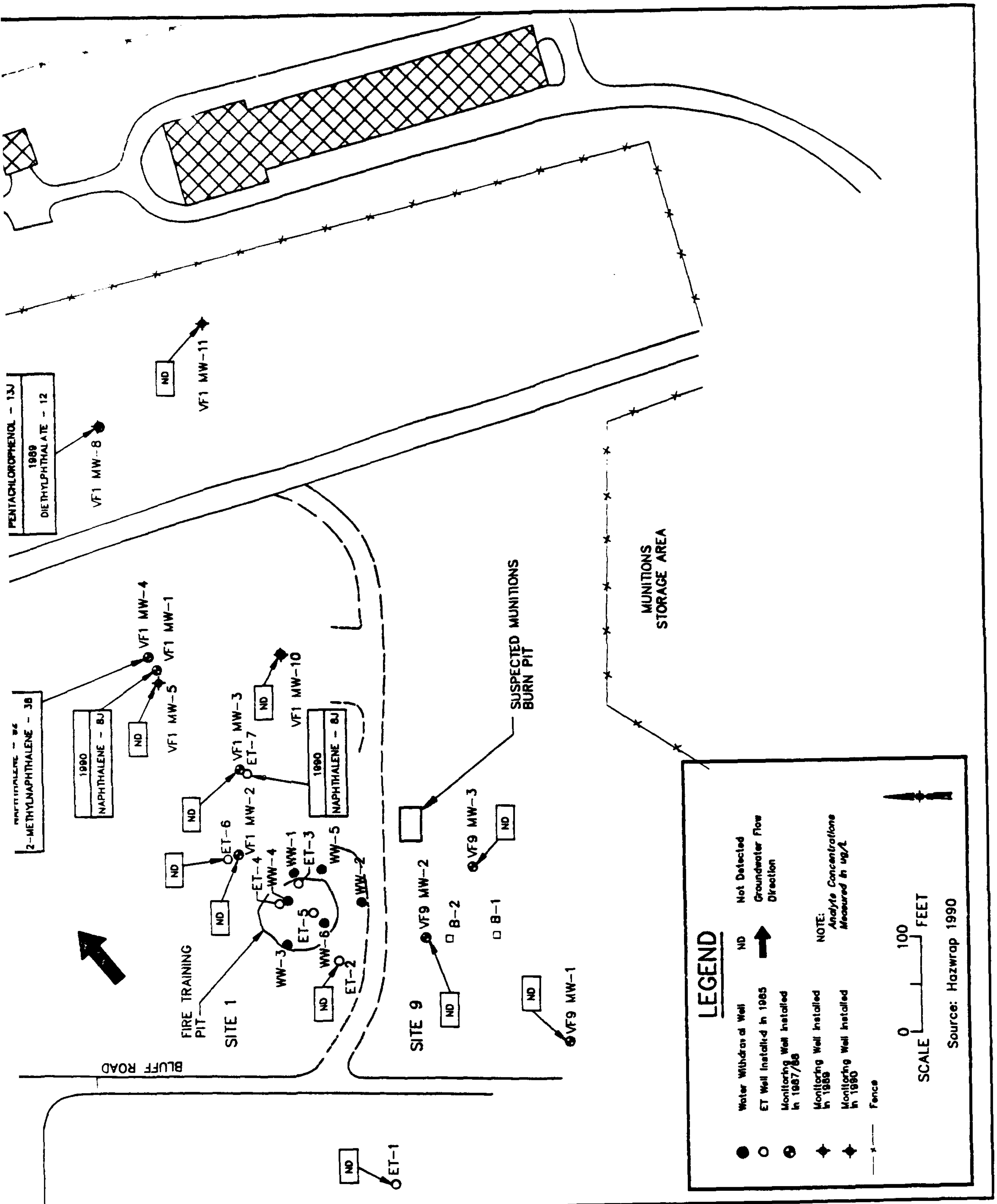


Figure 5.15

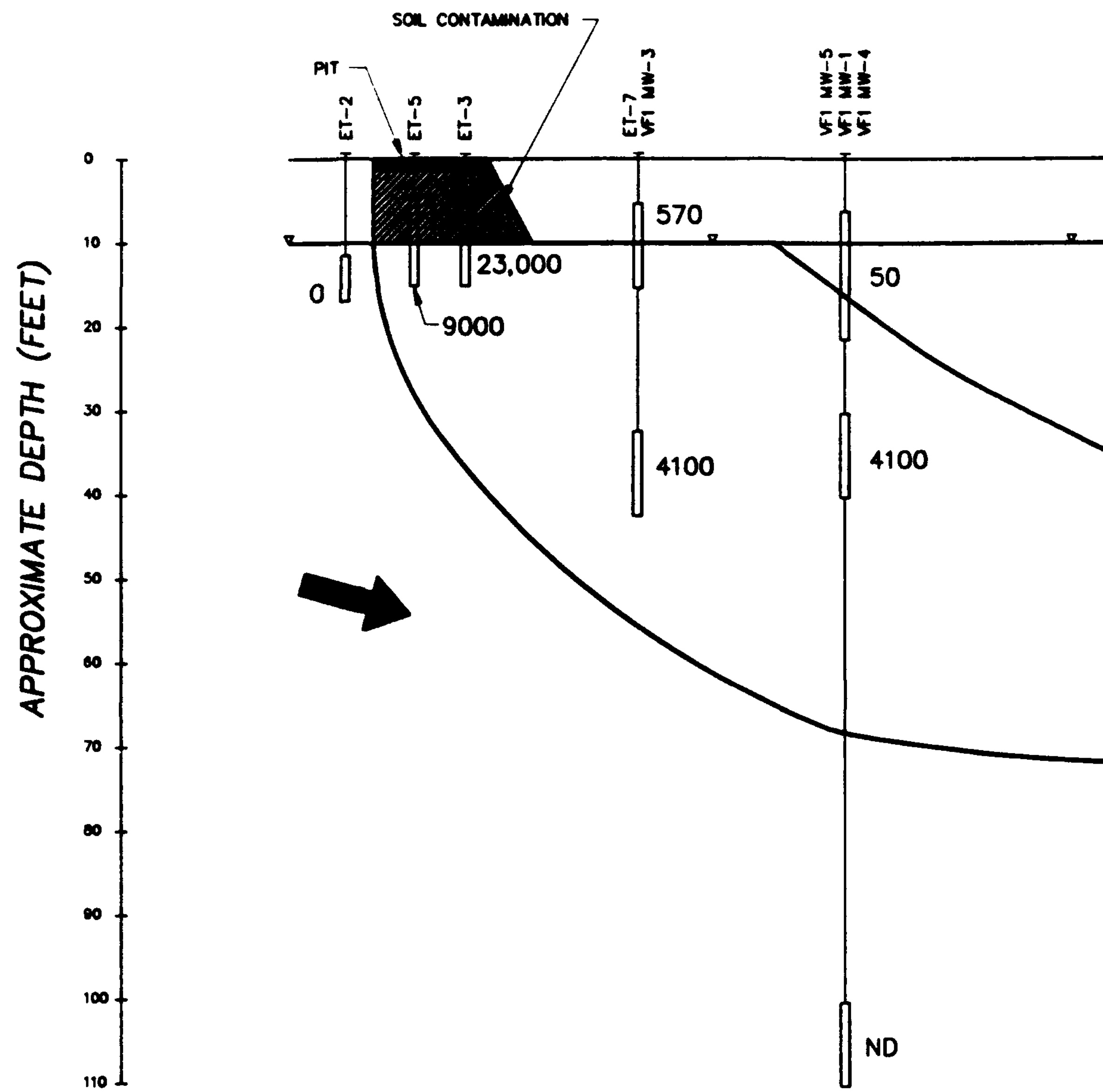


LEGEND
Water Withdrawal Well
ET Well Installed in 1985
Monitoring Well Installed in 1987/88
Monitoring Well Installed in 1989
Monitoring Well Installed in 1990
Fence
ND Not Detected
Groundwater Flow Direction
NOTE: Analyte Concentrations Measured in ug/L
SCALE 0 100 FEET
Source: Hazwrap 1990
MUNITIONS STORAGE AREA
SUSPECTED MUNITIONS BURN PIT
FIRE TRAINING PIT
SITE 1
SITE 9
BLUFF ROAD
1989 PENTACHLOROPHENOL - 13J DIETHYLPHTHALATE - 12
2-METHYLNAPHTHALENE - 38
1990 NAPHTHALENE - 8J
1990 NAPHTHALENE - 8J
VF1 MW-1
VF1 MW-2
VF1 MW-3
VF1 MW-4
VF1 MW-5
VF1 MW-8
VF1 MW-10
VF1 MW-11
VF9 MW-1
VF9 MW-2
VF9 MW-3
WW-1
WW-2
WW-3
WW-4
WW-5
WW-6
ET-1
ET-2
ET-3
ET-4
ET-5
ET-6
ET-7
B-1
B-2
ND

SITE 1, FIRE TRAIN

CONCEPTUALIZED VERTICAL EXTENT OF

VOLK FIELD ANG



NOTE: This section is intended to
groundwater contamination.
screen intervals are approxin
projected onto this line of s
screen interval is the approx
organics in parts per billion
Data from wells ET-3 and E

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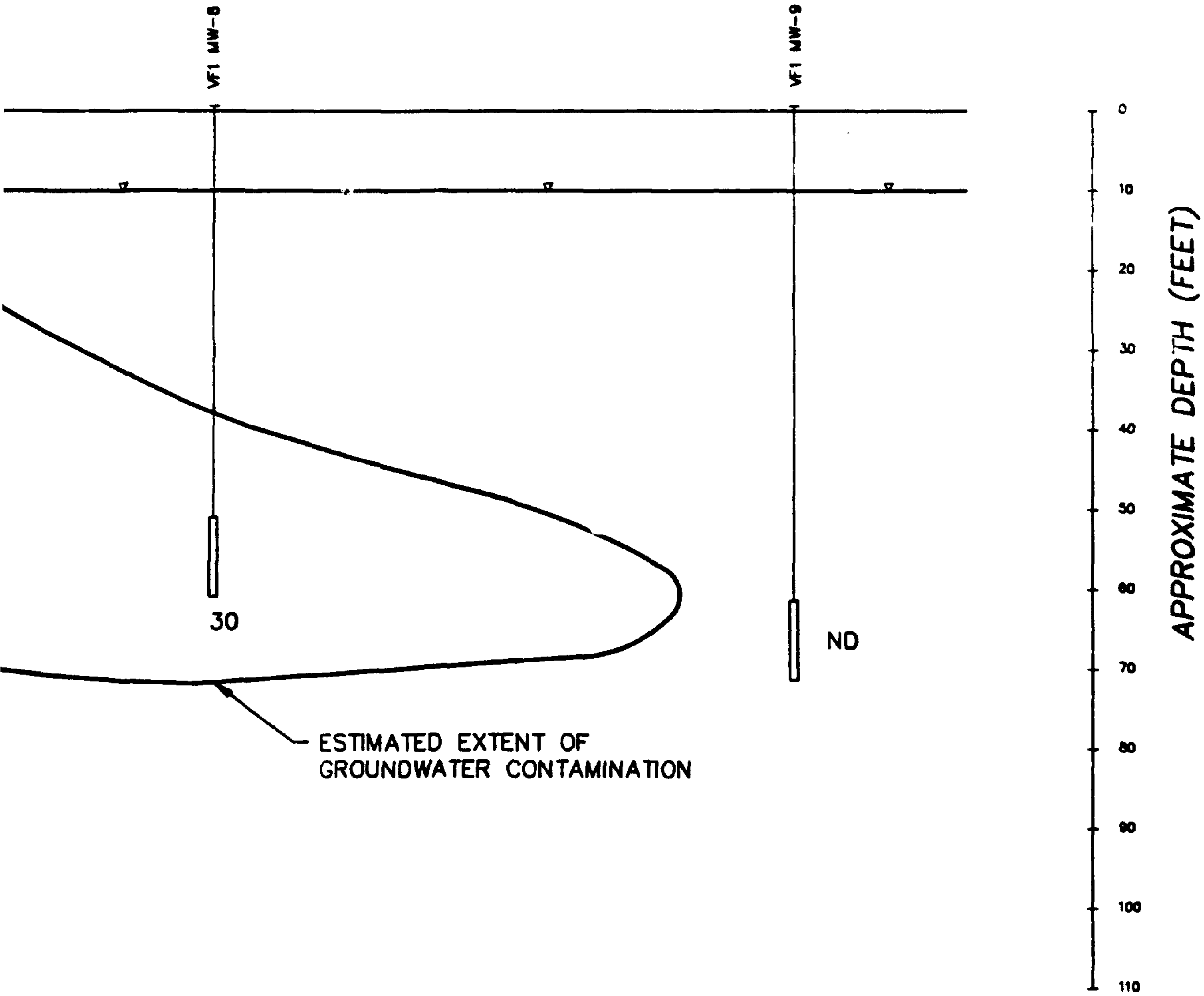
RE TRAINING AREA
ENT OF GROUNDWATER CONTAMINATION
: FIELD ANGB, WI



intended to present a conceptual model of
ontamination. Depth to the water table and
ls are approximate. Well locations have been
this line of section. Number beside the
is the approximate concentration of total volatile
rts per billion for various sampling events.
ls ET-3 and ET-5 are from 1988 (ES, 1990b).

LEGEND

Approximate
Screened Interval
4100 total voc's (ppb)

General Direction of
Groundwater Flow

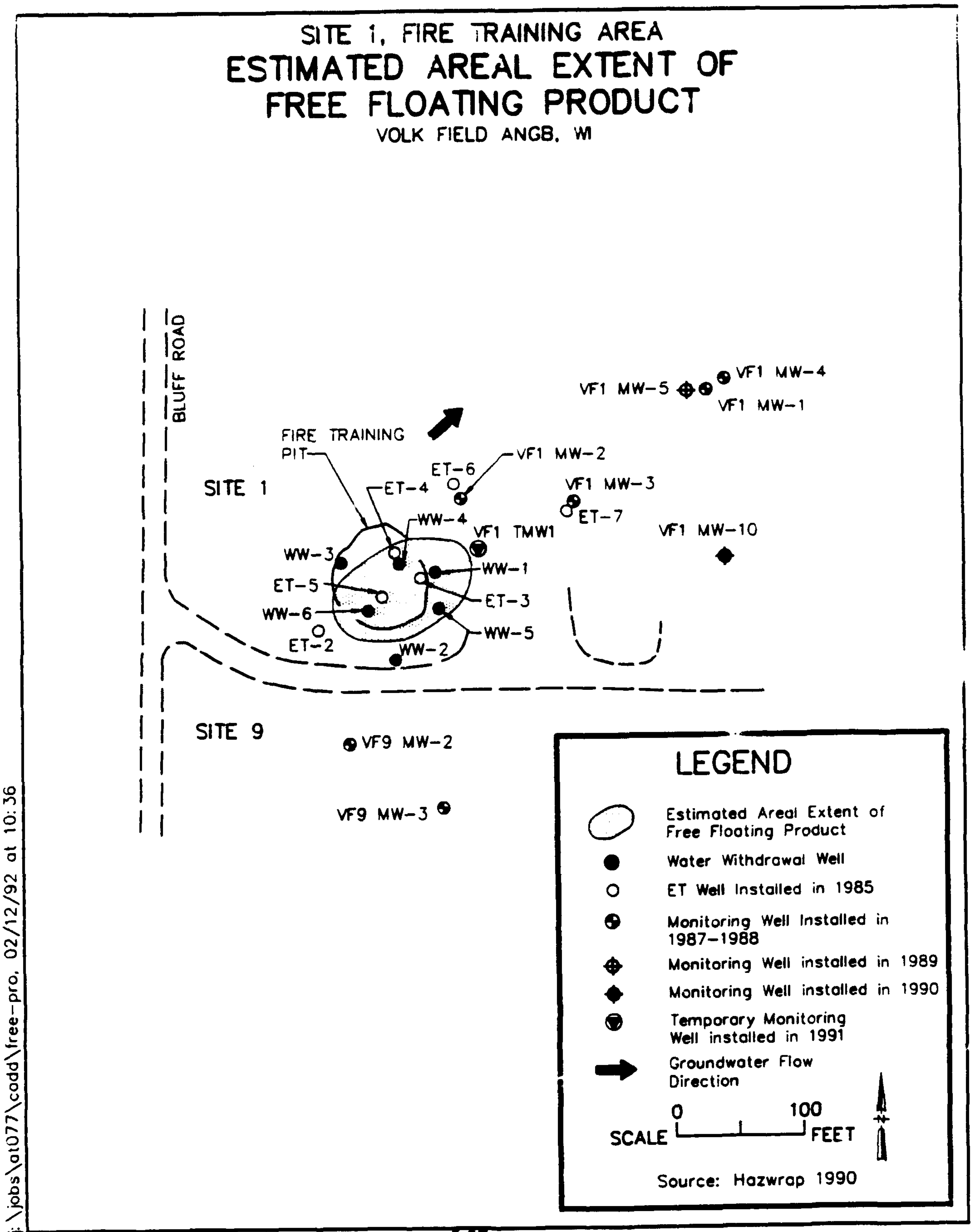
Approximated
Topographic Surface

Approximate
Water Table

SCALE 0 100 200 FEET

ENGINEERING–SCIENCE

Figure 5.17



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ENGINEERING-SCIENCE

TABLE 5.1
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF1 SB13 (a)	VF1 SB16 Composite	VF1 SB17-SS1 (1.0-3.0)	VF1 SB17-SS2 (4.0-6.0)	VF1 SB18-SS1 (1.0-3.0)	VF1 SB18-SS2 (4.0-6.0)
Date Sampled	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89
13 Priority Pollutant Metals (mg/kg)						
Chromium	2.3	2.0	3.2	1.4	4.6	1.4
Copper	1.7	1.2	1.4	U	10	U
Nickel	U	U	U	U	1.1	U
Zinc	3.8	3.4	3.9	U	44	6.7
Lead	1.2	1.6	2.0	0.67	100	12

ND – No analytes detected for this method.
U – Below the detection limit.
J2, J3, J4 – Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
(a) Duplicate of VF1-SB16.

TABLE 5.1 (cont'd)
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF1 SB19-SS1 (0-2.0)	VF1 SB19-SS2 (5.5-8.0)	VF1 SB35-SS2 (5.5-8.0)(b)	VF1 SB20-SS1 (0-2.5)	VF1 SB20-SS2 (5.5-8.0)	VF1 SB21-SS1 (0-2.5)	VF1 SB21-SS2 (5.5-8.0)	VF1 SB36-SS2 (5.5-8.0)(c)
Date Sampled	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89
Halogenated Volatiles - SW8010(ug/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020(ug/kg)								
Toluene	11J2	5.5J2	U	U	5.5	U	U	U
Total Petroleum Hydrocarbons E418.1(mg/kg)	U	U	U	U	U	U	U	U
Semivolatile Organics - CLP SOW(ug/kg)								
Bis(2-ethylhexyl)phthalate	U	U	U	U	U	UJ2	UJ2	UJ2
Lead - SW7421(mg/kg)	2.2	2.7	2.2	3.7	0.92	4.3	1.3	1.3

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.

(b) - Duplicate of VF1-SB19-SS2.
(c) - Duplicate of VF1-SB21-SS2.

TABLE 5.1 (cont'd)
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF1 SB22-SS1 (0-2.5)	VF1 SB22-SS2 (5.5-8.0)	VF1 SB37-SS2 (5.5-8.0)(d)	VF1 SB23-SS1 (0-2.5)	VF1 SB23-SS2 (5.5-8.0)	VF1 SB23-SS3 (10.0-12.5)	VF1 SB24-SS1 (0-2.0)	VF1 SB24-SS2 (5.5-8.0)
Date Sampled	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89	11/07/89
Halogenated Volatiles - SW8010(ug/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020(ug/kg) Toluene	U	U	U	U	U	U	U	U
Total Petroleum Hydrocarbons E418.1(mg/kg)	U	U	U	485	U	U	660	1,000
Semivolatile Organics - CLP SOW(ug/kg) Bis(2-ethylhexyl)phthalate	U	UJ2	UJ2	UJ2	UJ2	UJ2	650	1100J2
Lead - SW7421(mg/kg)	1.8	1.2	1.1	4.4	2.0	1.3	7.6	3.3

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.

(d) - Duplicate of VF1-SB22-SS2.

TABLE 5.1 (cont'd)
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF1 SB25-SS1 (0-2.0)	VF1 SB25-SS2 (5.5-8.0)	VF1 SB26-SS1 (1.0-2.0)	VF1 SB26-SS2 (5.5-8.0)	VF1 SB27-SS1 (0-2.0)	VF1 SB27-SS2 (5.5-8.0)	VF1 SB38 (5.5-8.0)(e)
Date Sampled	11/28/89	11/28/89	11/08/89	11/08/89	11/08/89	11/08/89	11/08/89
Halogenated Volatiles - SW8010(ug/kg)	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020(ug/kg) Toluene	U	U	U	U	U	U	U
Total Petroleum Hydrocarbons E418.1(mg/kg)	730	1,350	20	36	U	U	U
Semivolatile Organics - CLP SOW(ug/kg) Bis(2-ethylhexyl)phthalate	U	U	U	UJ2	UJ2	U	UJ2
Lead - SW7421(mg/kg)	37	15	18	4.2	1.7	1.2	1.2

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.

(e) - Duplicate of VF1-SB27-SS2.

TABLE 5.1 (cont'd)
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VFI SB28-SS1 (0-2.5)	VFI SB28-SS2 (5.5-8.0)	VFI SB29-SS1 (0-2.0)	VFI SB29-SS2 (5.5-8.0)	VFI SB30-SS1 (0-2.0)	VFI SB30-SS2 (5.5-8.0)	VFI SB31-SS1 (0-2.0)	VFI SB31-SS2 (5.5-8.0)
Date Sampled	11/07/89	11/07/89	11/08/89	11/08/89	11/08/89	11/08/89	11/08/89	11/08/89
Halogenated Volatiles - SW8010(ug/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020(ug/kg)								
Toluene	U	U	U	U	U	U	U	U
Total Petroleum Hydrocarbons E418.1(mg/kg)	U	U	380	20	24	26	28	U
Semivolatile Organics - CLP SOW(ug/kg)								
Bis(2-ethylhexyl)phthalate	UJ2	UJ2	U	U	UJ2	U	U	U
Lead - SW7421(mg/kg)	2.7	1.5	1.7	0.78	2.7	1.7	2.2	0.75

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.

TABLE 5.2
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF1-MW5	VF1-MW6	VF1-MW7	VF1-MW8
Date Sampled	11/02/89	11/03/89	11/03/89	11/04/89
Halogenated Volatiles - SW8010(ug/L)				
Trichloroethene	U	U	U	19
Aromatic Volatiles - SW8020(ug/L)				
Benzene	12J2	U	U	3.4J2
Toluene	4.6J2	U	U	U
Xylenes	2.6J2	U	U	3.6J2
Total Petroleum Hydrocarbons - E418.1(mg/L)	U	U	U	U
Total Dissolved Solids - E160.1(mg/L)	UJ3	170	64	53
Semivolatile Organics - CLP SOW(ug/L)				
Diethyl phthalate	U	U	U	12
13 Priority Pollutant Metals (ug/L)				
Copper	13	U	U	U
Zinc	30U	39U	80U	87
Lead	U	13	24	5.6

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.

TABLE 5.3
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameter	VF1 MW1	VF1 MW2	VF1 MW13(a)	VF1 MW3	VF1 MW4	VF1 MW5-1X	VF1 MW5-2X	VF1 MW5	VF1 MW6	VF1 MW7	VF1 MW8
Date Sampled	11/05/90	11/07/90	11/07/90	11/07/90	11/05/90	09/25/90	10/02/90	11/08/90	11/07/90	11/07/90	11/08/90
Halogenated Volatiles - SW8010(ug/L)											
Trichloroethene	1.7	U	U	U	U	U	U	U	U	U	U
Aromatic Volatiles - SW8020(ug/L)											
Benzene	37	U	U	2,600J2	1,800	U	U	U	U	U	8.1
Ethylbenzene	5.3	U	U	150J2	370	U	U	U	U	U	UJ2
Toluene	2.7	1.3	0.95	1,200	770	U	U	U	U	U	U
Xylenes	1.7	U	U	140	1100	UJ2	U	U	U	U	U
Total Petroleum Hydrocarbons E418.1(mg/L)	U	U	2.3	1.6	5.2	NA	NA	U	4.0	2.4	U
Semivolatile Organics - CLP SOW(ug/L)											
Pentachlorophenol	U	U	U	U	U	NA	NA	U	U	U	13J
Naphthalene	8J	U	U	U	92J4	NA	NA	U	U	U	U
2-Methylnaphthalene	U	U	U	U	38J4	NA	NA	U	U	U	U
13 Priority Pollutant Metals (ug/L)											
Nickel	U	U	U	U	11.4	NA	NA	U	U	U	U
Zinc	U	41.6	U	U	U	NA	NA	16.5	11.3	21.2	16.4
Arsenic	U	U	U	U	10.5J	NA	NA	U	U	U	U
Total Dissolved Solids - E160.1(mg/L)	67	59	63	120	330	NA	NA	17	28	51	37

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn
Analytical methods found in Section 3.

(a) Duplicate for VF1-MW2.

TABLE 5.3 (cont'd)
SITE 1, FIRE TRAINING AREA
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameter	VF1 MW9	VF1 MW14(b)	VF1 MW10	VF1 MW11	VF1 MW12-1X	VF1 MW25-1X(c)	VF1 MW12	VF1 ET1	VF1 ET2	VF1 ET6	VF1 ET7
Date Sampled	11/08/90	11/08/90	11/08/90	11/08/90	10/10/90	10/10/90	11/07/90	10/24/90	11/06/90	11/06/90	11/07/90
Halogenated Volatiles - SW8010(ug/L)											
Trichloroethene	U	U	U	U	U	U	U	U	U	U	U
Aromatic Volatiles - SW8020(ug/L)											
Benzene	U	U	U	U	U	U	U	U	U	U	87J2
Ethylbenzene	U	U	U	U	U	U	U	U	U	U	54J2
Toluene	U	U	U	U	U	U	U	U	U	U	200
Xylenes	U	U	U	U	U	U	U	U	U	U	230
Total Petroleum Hydrocarbons E418.1(mg/L)	U	U	U	U	NA	NA	1.4	U	U	2.7	U
Semivolatile Organics - CLP SOW(ug/L)											
Pentachlorophenol	U	U	U	U	NA	NA	U	U	U	U	U
Naphthalene	U	U	U	U	NA	NA	U	U	U	U	8J
2-Methylnaphthalene	U	U	U	U	NA	NA	U	U	U	U	U
13 Priority Pollutant Metals (ug/L)											
Nickel	U	U	U	U	NA	NA	U	U	U	U	U
Zinc	18.8	16.5	36.8	16.8	NA	NA	20.7	19.3	U	22.6	14.1
Arsenic	U	U	U	U	NA	NA	U	U	U	U	U
Total Dissolved Solids - E160.1(mg/L)	30	22	38	28	NA	NA	42	42	45	73	67

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn
Analytical methods found in Section 3.

(b) Duplicate for VF1-MW9
(c) Duplicate for VF1-MW12-1X

TABLE 5.4
SITE 1, FIRE TRAINING AREA
SUMMARY OF FREE PRODUCT
VOLK FIELD ANGB, WI

	Free Floating Product Thickness(1)						
Monitoring Well I.D.	4/88 (in)	11/90 (in)	7/91 (in)	10/29/91 (in)	11/1/91 (in)	11/1/91 (2) (in)	11/2/91 (in)
MW-2	--	--	--, 0	--	--	--	--
MW-3	--	0	--, --	--	--	--	--
							--
WW-1	--	2.5	2.0, 2.5	1.1	0.5, 0.2 (4)	0.2	0
WW-2	--	--	0, 0	0	--	--	--
WW-3	0	--	0, 0	0	--	--	--
WW-4	0	--	0, 0.1 (3)	0	0	--	--
WW-5	--	0.1	0, 0.1 (3)	0	0	--	--
WW-6	0	2.5	13.9, 13 (4)	0.5, 0.1	0.5, 0.3 (4)	0.2	0.2
ET-2	0	--	--, 0	0	--	--	--
ET-3	0	3.1	2.9, 2.8	8.3 (4)	9.4, 7.9 (4)	2.5	6.2
ET-4	0	0.1	0, 0.1 (3)	0, sheen	--	--	--
ET-5	0	0.1	4.4, 4.8	12.4 (4)	9.6, 9.8 (4)	0.7	4.3
ET-7	--	--	--, 0	--,0 (5)	0	--	--
TMW-1	--	--	--	0, sheen (3, 6)	0, sheen (3)	0, sheen	--

-- - Not measured.

(1) - First thickness indicates free product measured with oil/water probe. Second thickness indicates free product measured in acrylic bailer. If only one value is reported, this depth was measured with oil/water probe.

(2) - Approximately 2 hours after purging well of product.

(3) - Observed in glass jar upon settling.

(4) - Well purged free of product after measuring.

(5) - Possible product indicated with oil/water separator.

(6) - Measured on October 31, 1991.

TABLE 5.5
SITE 1, FIRE TRAINING AREA
CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS (TOP 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentrations (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	95% Upper Confidence Limit (a) (mg/kg)
Benzene	0.12-16	4 / 32	5.73E-01	2.79E+00	1.58E+00
Ethylbenzene	0.37-17	4 / 32	7.28E-01	3.04E+00	1.83E+00
Lead	0.8-85	32 / 32	1.15E+01	2.16E+01	1.93E+01
2-Methylnaphthalene	9.7	1 / 19(b)	8.23E-01	2.09E+00	1.83E+00
Petroleum Hydrocarbons	20-22000	17 / 32	1.54E+03	4.52E+03	3.17E+03
Tetrachloroethylene	0.00053-0.00094	3 / 32	3.81E-04	3.70E-04	5.14E-04
Toluene	0.011-3.6	5 / 32	2.48E-01	7.68E-01	5.25E-01
Trichloroethylene	0.008-0.041	3 / 32	3.61E-03	8.84E-03	6.79E-03
Xylene	2.2-83	4 / 32	3.44E+00	1.46E+01	8.71E+00

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size. If n < 5, the maximum detected concentration is presented instead of the 95% UCL.

(b) The 1989 surface soil samples were not analyzed for 2-Methylnaphthalene.

TABLE 5.6
SITE 1, FIRE TRAINING AREA
CHEMICALS OF CONCERN DETECTED IN DEEP SOILS (> 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentrations (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	95% Upper Confidence Limit (a) (mg/kg)
Benzene	0.041-19	7 / 48	8.93E-01	3.51E+00	1.91E+00
Chromium	1.4-4.6	4 / 4	2.65E+00	1.34E+00	4.60E+00
Copper	1.4-10	2 / 4	3.10E+00	4.00E+00	1.00E+01
Ethylbenzene	0.11-40	7 / 48	1.59E+00	6.21E+00	3.39E+00
Lead	0.5-100	40 / 52	4.52E+00	1.55E+01	8.82E+00
2-Methylnaphthalene	2.4-15	4 / 30	1.42E+00	3.54E+00	2.72E+00
Naphthalene	1.8-7.3	4 / 48	6.39E-01	1.45E+00	1.06E+00
Petroleum Hydrocarbons	20-8600	15 / 48	6.80E+02	1.82E+03	1.21E+03
Toluene	0.0055-37	9 / 48	1.04E+00	5.33E+00	2.58E+00
Trichloroethylene	0.00058-0.017	5 / 48	1.98E-03	3.31E-03	2.94E-03
Xylene	0.19-88	7 / 54	5.35E+00	1.85E+01	1.04E+01
Zinc	3.9-44	3 / 4	1.38E+01	1.76E+01	4.40E+01

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size. If n < 5, the maximum detected concentration is presented instead of the 95% UCL.

L\AT077\911J162\VF1COC

TABLE 5.7
SITE 1, FIRE TRAINING AREA
CHEMICALS OF CONCERN DETECTED IN GROUNDWATER
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentrations (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (a) (mg/L)
Benzene	0.0012-8.27	16 / 36	5.54E-01	1.57E+00	1.09E+00
Bis(2-ethylhexyl)phthalate	0.009-1.1	3 / 32	3.92E-02	1.91E-01	1.08E-01
1,1-Dichloroethane	0.0016-0.012	2 / 36	7.17E-04	1.93E-03	1.37E-03
t-1,3-Dichloropropene	.0015-0.01	2 / 36	8.43E-04	1.61E-03	1.39E-03
Ethylbenzene	0.0053-0.535	10 / 36	5.59E-02	1.25E-01	9.81E-02
Lead (Dissolved)	0.0056-0.024	3 / 21	4.17E-03	4.99E-03	6.44E-03
Naphthalene	0.0023-0.092	10 / 32	1.26E-02	1.95E-02	1.97E-02
Pentachlorophenol	0.005-0.076	3 / 32	1.91E-02	1.46E-02	2.44E-02
Petroleum Hydrocarbons	1.4-110	11 / 32	5.80E+00	1.94E+01	1.28E+01
Phenol	0.003-0.028	4 / 32	5.66E-03	6.00E-03	7.82E-03
Toluene	0.00044-12.7	15 / 36	5.89E-01	2.17E+00	1.32E+00
Trichloroethylene	0.0007-0.079	8 / 36	3.74E-03	1.33E-02	8.22E-03
Xylene	0.0017-1.800	15 / 36	2.01E-01	4.58E-01	3.56E-01
Zinc (Dissolved)	0.0113-0.087	13 / 21	2.01E-02	1.85E-02	2.85E-02

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size. If n < 5, the maximum detected concentration is presented instead of the 95% UCL.

TABLE 5.8

SITE 1, FIRE TRAINING AREA
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 1; areas downwind	Onsite workers, nearby residents	Inhalation	Low. VOCs have been detected in soils. Odors were detected during field investigations.
	Contaminated surface soils/ fugitive dust generation	Site 1; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. High concentrations of Zn, Cr, Cu, and Pb were detected in burn pit soils collected in 1989. The main burn pit is covered with sand and gravel which will retard erosion of contaminated soils. The second burn pit is not covered.
Groundwater	Contaminated soils/leaching to groundwater	Base supply wells W3 and W4	Base workers and residents	Oral, dermal, inhalation	None. No contaminants were detected in these wells.
		Downgradient wells	Nearby residents	Oral, dermal, inhalation.	Unlikely. No VOCs were detected in wells of six residences NE of the base as of 1984. The Base Boundary well is not contaminated; however, contaminants were detected in monitoring wells downgradient of Site 1.
Surface Water	Contaminated soils and groundwater/ surface runoff, groundwater seepage	Lemonwier River	Nearby residents who might swim in the river	Oral, dermal, inhalation	Unlikely. The site is flat and the river is >2 miles away; there are no surface water intakes for drinking water supply.

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TABLE 5.8-Continued

SITE 1, FIRE TRAINING AREA
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
Soils	Contaminated soils, groundwater/ leaching, runoff, tracking	Site 1	Onsite workers, nearby residents	Oral, derma	[illegible] low. The most heavily contaminated surface soils are in burn-pit areas. Main burn pit is covered with sand and gravel which will prevent contact. The second burr. pit is not covered.
FUTURE USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 1; areas downwind	Future residents, onsite workers	Inhalation	Very low. Less than for current use due to degradation/dispersion of contaminants.
	Contaminated soils/fugitive dust generation	Site 1; areas downwind	Future residents, onsite workers	Inhalation	Very low. Less than for current use due to degradation/dispersion of contaminants.
Groundwater	Contaminated soils/leaching to groundwater	Wells onsite or downgradient	Future residents, onsite workers	Oral, dermal, inhalation	Very low. Groundwater contamination is present.
Surface Water	Contaminated soil and groundwater/ surface runoff, groundwater seepage	Lemonwier River	Nearby residents	Oral, dermal, inhalation	Unlikely. The site is flat and the river is >2 miles away. There are no surface water intakes for drinking water supply.
Soils	Contaminated soils, groundwater/ leaching, runoff, tracking	Site 1	Future residents, onsite workers	Oral, dermal	Very low. Exposure to surface and deeper soils is possible if excavation occurs and/or residences are constructed onsite

TABLE 5.9
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.58E+00	1.10E-06	1.74E-06	2.90E-02	5.04E-08
Lead	1.93E+01	1.10E-06	2.12E-05	ND	NA
Tetrachloroethylene	5.14E-04	1.10E-06	5.65E-10	5.10E-02	2.88E-11
Trichloroethylene	6.79E-03	1.10E-06	7.47E-09	1.10E-02	8.22E-11
				CARCINOGENIC RISK =	5E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.10
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	1.28E-05	2.02E-05	ND	NA
Ethylbenzene	1.83E+00	1.28E-05	2.34E-05	1.00E-01	2.34E-04
Lead	1.93E+01	1.28E-05	2.47E-04	ND	NA
2-Methylnaphthalene	1.83E+00	1.28E-05	2.34E-05	ND	NA
Petroleum Hydrocarbons	3.17E 03	1.28E-05	4.06E-02	ND	NA
Tetrachloroethylene	5.14E-04	1.28E-05	6.58E-09	1.00E-02	6.58E-07
Toluene	5.25E-01	1.28E-05	6.72E-06	2.00E-01	3.36E-05
Trichloroethylene	6.79E-03	1.28E-05	8.69E-08	ND	NA
Xylene	8.71E+00	1.28E-05	1.11E-04	2.00E+00	5.57E-05
				HAZARD INDEX =	3E-04

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 5.11
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.58E+00	3.49E-07	5.51E-07	2.90E-02	1.60E-08
Lead	1.93E+01	3.49E-07	6.74E-06	ND	NA
Tetrachloroethylene	5.14E-04	3.49E-07	1.79E-10	5.10E-02	9.15E-12
Trichloroethylene	6.79E-03	3.49E-07	2.37E-09	1.10E-02	2.61E-11
				CARCINOGENIC RISK =	2E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.12
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	9.78E-07	1.55E-06	ND	NA
Ethylbenzene	1.83E+00	9.78E-07	1.79E-06	1.00E-01	1.79E-05
Lead	1.93E+01	9.78E-07	1.89E-05	ND	NA
2-Methylnaphthalene	1.83E+00	9.78E-07	1.79E-06	ND	NA
Petroleum Hydrocarbons	3.17E+03	9.78E-07	3.10E-03	ND	NA
Tetrachloroethylene	5.14E-04	9.78E-07	5.03E-10	1.00E-02	5.03E-08
Toluene	5.25E-01	9.78E-07	5.13E-07	2.00E-01	2.57E-06
Trichloroethylene	6.79E-03	9.78E-07	6.64E-09	ND	NA
Xylene	8.71E+00	9.78E-07	8.52E-06	2.00E+00	4.26E-06
				HAZARD INDEX =	2E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.13
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF
SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.58E+00	5.87E-07	9.27E-07	2.90E-02	2.69E-08
Lead	1.93E+01	5.87E-07	1.13E-05	ND	NA
Tetrachloroethylene	5.14E-04	5.87E-07	3.02E-10	5.10E-02	1.54E-11
Trichloroethylene	6.79E-03	5.87E-07	3.99E-09	1.10E-02	4.38E-11
				CARCINOGENIC RISK =	3E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.14
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	1.37E-06	2.16E-06	ND	NA
Ethylbenzene	1.83E+00	1.37E-06	2.51E-06	1.00E-01	2.51E-05
Lead	1.93E+01	1.37E-06	2.64E-05	ND	NA
2-Methylnaphthalene	1.83E+00	1.37E-06	2.51E-06	ND	NA
Petroleum Hydrocarbons	3.17E+03	1.37E-06	4.34E-03	ND	NA
Tetrachloroethylene	5.14E-04	1.37E-06	7.04E-10	1.00E-02	7.04E-08
Toluene	5.25E-01	1.37E-06	7.19E-07	2.00E-01	3.60E-06
Trichloroethylene	6.79E-03	1.37E-06	9.30E-09	ND	NA
Xylene	8.71E+00	1.37E-06	1.19E-05	2.00E+00	5.97E-06
				HAZARD INDEX =	3E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.15
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.58E+00	1.60E-06	2.53E-06	2.90E-02	7.33E-08
Lead	1.93E+01	NA (d)	NA	ND	NA
Tetrachloroethylene	5.14E-04	1.60E-06	8.22E-10	5.10E-02	4.19E-11
Trichloroethylene	6.79E-03	1.60E-06	1.09E-08	1.10E-02	1.20E-10
				CARCINOGENIC RISK =	7E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.16
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	1.86E-05	2.94E-05	ND	NA
Ethylbenzene	1.83E+00	1.86E-05	3.40E-05	1.00E-01	3.40E-04
Lead	1.93E+01	NA (e)	NA	ND	NA
2-Methylnaphthalene	1.83E+00	1.86E-05	3.40E-05	ND	NA
Petroleum Hydrocarbons	3.17E+03	1.86E-05	5.90E-02	ND	NA
Tetrachloroethylene	5.14E-04	1.86E-05	9.56E-09	1.00E-02	9.56E-07
Toluene	5.25E-01	1.86E-05	9.77E-06	2.00E-01	4.88E-05
Trichloroethylene	6.79E-03	1.86E-05	1.26E-07	ND	NA
Xylene	8.71E+00	1.86E-05	1.62E-04	2.00E+00	8.10E-05
				HAZARD INDEX =	5E-04

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.17
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical Specific Risk
Benzene	1.58E+00	2.37E-06	3.74E-06	2.90E-02	1.09E-07
Lead	1.93E+01	NA (d)	NA	ND	NA
Tetrachloroethylene	5.14E-04	2.37E-06	1.22E-09	5.10E-02	6.21E-11
Trichloroethylene	6.79E-03	2.37E-06	1.61E-08	1.10E-02	1.77E-10
				CARCINOGENIC RISK =	1E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.18
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	6.64E-06	1.05E-05	ND	NA
Ethylbenzene	1.83E+00	6.64E-06	1.22E-05	1.00E-01	1.22E-04
Lead	1.93E+01	NA (e)	NA	ND	NA
2-Methylnaphthalene	1.83E+00	6.64E-06	1.22E-05	ND	NA
Petroleum Hydrocarbons	3.17E+03	6.64E-06	2.10E-02	ND	NA
Tetrachloroethylene	5.14E-04	6.64E-06	3.41E-09	1.00E-02	3.41E-07
Toluene	5.25E-01	6.64E-06	3.49E-06	2.00E-01	1.74E-05
Trichloroethylene	6.79E-03	6.64E-06	4.51E-08	ND	NA
Xylene	8.71E+00	6.64E-06	5.78E-05	2.00E+00	2.89E-05
				HAZARD INDEX =	2E-04

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.19
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.58E+00	9.43E-07	1.49E-06	2.90E-02	4.32E-08
Lead	1.93E+01	NA (d)	NA	ND	NA
Tetrachloroethylene	5.14E-04	9.43E-07	4.85E-10	5.10E-02	2.47E-11
Trichloroethylene	6.79E-03	9.43E-07	6.40E-09	1.10E-02	7.04E-11
				CARCINOGENIC RISK =	4E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.20
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.58E+00	2.20E-06	3.48E-06	ND	NA
Ethylbenzene	1.83E+00	2.20E-06	4.03E-06	1.00E-01	4.03E-05
Lead	1.93E+01	NA (e)	NA	ND	NA
2-Methylnaphthalene	1.83E+00	2.20E-06	4.03E-06	ND	NA
Petroleum Hydrocarbons	3.17E+03	2.20E-06	6.97E-03	ND	NA
Tetrachloroethylene	5.14E-04	2.20E-06	1.13E-09	1.00E-02	1.13E-07
Toluene	5.25E-01	2.20E-06	1.16E-06	2.00E-01	5.78E-06
Trichloroethylene	6.79E-03	2.20E-06	1.49E-08	ND	NA
Xylene	8.71E+00	2.20E-06	1.92E-05	2.00E+00	9.58E-06
				HAZARD INDEX =	6E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.21
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	1.10E-06	2.10E-06	2.90E-02	6.09E-08
Lead	8.82E+00	1.10E-06	9.70E-06	ND	NA
Trichloroethylene	2.94E-03	1.10E-06	3.23E-09	1.10E-02	3.56E-11
				CARCINOGENIC RISK =	6E-08

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND – Not Determined
NA – Not Applicable

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TABLE 5.22
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD 1/(mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	1.28E-05	2.44E-05	ND	NA
Chromium (d)	4.60E+00	1.28E-05	5.89E-05	5.00E-03	1.18E-02
Copper	1.00E+01	1.28E-05	1.28E-04	ND	NA
Ethylbenzene	3.39E+00	1.28E-05	4.34E-05	1.00E-01	4.34E-04
Lead	8.82E+00	1.28E-05	1.13E-04	ND	NA
2-Methylnaphthalene	2.72E+00	1.28E-05	3.48E-05	ND	NA
Naphthalene	1.06E+00	1.28E-05	1.36E-05	4.00E-03	3.39E-03
Petroleum Hydrocarbons	1.21E+03	1.28E-05	1.55E-02	ND	NA
Toluene	2.58E+00	1.28E-05	3.30E-05	2.00E-01	1.65E-04
Trichloroethylene	2.94E-03	1.28E-05	3.76E-08	ND	NA
Xylene	1.04E+00	1.28E-05	1.33E-05	2.00E+00	6.66E-06
Zinc	4.40E+01	1.28E-05	5.63E-04	2.00E-01	2.82E-03
				HAZARD INDEX =	2E-02

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 5.23
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	3.49E-07	6.67E-07	2.90E-02	1.93E-08
Lead	8.82E+00	3.49E-07	3.08E-06	ND	NA
Trichloroethylene	2.94E-03	3.49E-07	1.03E-09	1.10E-02	1.13E-11
				CARCINOGENIC RISK =	2E-08

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.24
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD 1/(mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	9.78E-07	1.87E-06	ND	NA
Chromium (d)	4.60E+00	9.78E-07	4.50E-06	5.00E-03	9.00E-04
Copper	1.00E+01	9.78E-07	9.78E-06	ND	NA
Ethylbenzene	3.39E+00	9.78E-07	3.32E-06	1.00E-01	3.32E-05
Lead	8.82E+00	9.78E-07	8.63E-06	ND	NA
2-Methylnaphthalene	2.72E+00	9.78E-07	2.66E-06	ND	NA
Naphthalene	1.06E+00	9.78E-07	1.04E-06	4.00E-03	2.59E-04
Petroleum Hydrocarbons	1.21E+03	9.78E-07	1.18E-03	ND	NA
Toluene	2.58E+00	9.78E-07	2.52E-06	2.00E-01	1.26E-05
Trichloroethylene	2.94E-03	9.78E-07	2.88E-09	ND	NA
Xylene	1.04E+00	9.78E-07	1.02E-06	2.00E+00	5.09E-07
Zinc	4.40E+01	9.78E-07	4.30E-05	2.00E-01	2.15E-04
				HAZARD INDEX =	1E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 5.25
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	5.87E-07	1.12E-06	2.90E-02	3.25E-08
Lead	8.82E+00	5.87E-07	5.18E-06	ND	NA
Trichloroethylene	2.94E-03	5.87E-07	1.73E-09	1.10E-02	1.90E-11
				CARCINOGENIC RISK =	3E-08

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.26
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD 1/(mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	1.37E-06	2.62E-06	ND	NA
Chromium (d)	4.60E+00	1.37E-06	6.30E-06	5.00E-03	1.26E-03
Copper	1.00E+01	1.37E-06	1.37E-05	ND	NA
Ethylbenzene	3.39E+00	1.37E-06	4.64E-06	1.00E-01	4.64E-05
Lead	8.82E+00	1.37E-06	1.21E-05	ND	NA
2-Methylnaphthalene	2.72E+00	1.37E-06	3.73E-06	ND	NA
Naphthalene	1.06E+00	1.37E-06	1.45E-06	4.00E-03	3.63E-04
Petroleum Hydrocarbons	1.21E+03	1.37E-06	1.66E-03	ND	NA
Toluene	2.58E+00	1.37E-06	3.53E-06	2.00E-01	1.77E-05
Trichloroethylene	2.94E-03	1.37E-06	4.03E-09	ND	NA
Xylene	1.04E+00	1.37E-06	1.42E-06	2.00E+00	7.12E-07
Zinc	4.40E+01	1.37E-06	6.03E-05	2.00E-01	3.01E-04
				HAZARD INDEX =	2E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 5.27
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemcial	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	1.60E-06	3.06E-06	2.90E-02	8.86E-08
Lead	8.82E+00	NA (d)	NA	ND	NA
Trichloroethylene	2.94E-03	1.60E-06	4.70E-09	1.10E-02	5.17E-11
				CARCINOGENIC RISK =	9E-08

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.28
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	1.86E-05	3.55E-05	ND	NA
Chromium (f)	4.60E+00	NA (e)	NA	5.00E-03	NA
Copper	1.00E+01	NA (e)	NA	ND	NA
Ethylbenzene	3.39E+00	1.86E-05	6.31E-05	1.00E-01	6.31E-04
Lead	8.82E+00	NA (e)	NA	ND	NA
2-Methylnaphthalene	2.72E+00	1.86E-05	5.06E-05	ND	NA
Naphthalene	1.06E+00	1.86E-05	1.97E-05	4.00E-03	4.93E-03
Petroleum Hydrocarbons	1.21E+03	1.86E-05	2.25E-02	ND	NA
Toluene	2.58E+00	1.86E-05	4.80E-05	2.00E-01	2.40E-04
Trichloroethylene	2.94E-03	1.86E-05	5.47E-08	ND	NA
Xylene	1.04E+00	1.86E-05	1.93E-05	2.00E+00	9.67E-06
Zinc	4.40E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	6E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) *Dermal absorption for metals = 0.*
(f) RfD used is for Chromium (VI).
ND – Not Determined
NA – Not Applicable

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TABLE 5.29
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	2.37E-06	4.53E-06	2.90E-02	1.31E-07
Lead	8.82E+00	NA (d)	NA	ND	NA
Trichloroethylene	2.94E-03	2.37E-06	6.97E-09	1.10E-02	7.66E-11
			CARCINOGENIC RISK =		1E-07

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.30
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	6.64E-06	1.27E-05	ND	NA
Chromium (f)	4.60E+00	NA (e)	NA	5.00E-03	NA
Copper	1.00E+01	NA (e)	NA	ND	NA
Ethylbenzene	3.39E+00	6.64E-06	2.25E-05	1.00E-01	2.25E-04
Lead	8.82E+00	NA (e)	NA	ND	NA
2-Methylnaphthalene	2.72E+00	6.64E-06	1.81E-05	ND	NA
Naphthalene	1.06E+00	6.64E-06	7.04E-06	4.00E-03	1.76E-03
Petroleum Hydrocarbons	1.21E+03	6.64E-06	8.03E-03	ND	NA
Toluene	2.58E+00	6.64E-06	1.71E-05	2.00E-01	8.57E-05
Trichloroethylene	2.94E-03	6.64E-06	1.95E-08	ND	NA
Xylene	1.04E+00	6.64E-06	6.91E-06	2.00E+00	3.45E-06
Zinc	4.40E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	2E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 5.31
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.91E+00	9.43E-07	1.80E-06	2.90E-02	5.22E-08
Lead	8.82E+00	NA (d)	NA	ND	NA
Trichloroethylene	2.94E-03	9.43E-07	2.77E-09	1.10E-02	3.05E-11
			CARCINOGENIC RISK =		5E-08

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.32
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.91E+00	2.20E-06	4.20E-06	ND	NA
Chromium (f)	4.60E+00	NA (e)	NA	5.00E-03	NA
Copper	1.00E+01	NA (e)	NA	ND	NA
Ethylbenzene	3.39E+00	2.20E-06	7.46E-06	1.00E-01	7.46E-05
Lead	8.82E+00	NA (e)	NA	ND	NA
2-Methylnaphthalene	2.72E+00	2.20E-06	5.98E-06	ND	NA
Naphthalene	1.06E+00	2.20E-06	2.33E-06	4.00E-03	5.83E-04
Petroleum Hydrocarbons	1.21E+03	2.20E-06	2.66E-03	ND	NA
Toluene	2.58E+00	2.20E-06	5.68E-06	2.00E-01	2.84E-05
Trichloroethylene	2.94E-03	2.20E-06	6.47E-09	ND	NA
Xylene	1.04E+00	2.20E-06	2.29E-06	2.00E+00	1.14E-06
Zinc	4.40E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	7E-04

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 5.33
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.09E+00	1.10E-02	1.20E-02	2.90E-02	3.48E-04
Bis(2-ethylhexyl)phthalate	1.08E-01	1.10E-02	1.19E-03	1.40E-02	1.66E-05
1,1-Dichloroethane	1.37E-03	1.10E-02	1.51E-05	ND	NA
t-1,3-Dichloropropene	1.39E-03	1.10E-02	1.53E-05	1.80E-01	2.75E-06
Lead (Dissolved)	6.44E-03	1.10E-02	7.08E-05	ND	NA
Pentachlorophenol	2.44E-02	1.10E-02	2.68E-04	1.20E-01	3.22E-05
Trichloroethylene	8.22E-03	1.10E-02	9.04E-05	1.10E-02	9.95E-07
				CARCINOGENIC RISK =	4E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.34
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration in Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.09E+00	1.28E-01	1.40E-01	ND	NA
Bis(2-ethylhexyl)phthalate	1.08E-01	1.28E-01	1.38E-02	2.00E-02	6.91E-01
1,1-Dichloroethane	1.37E-03	1.28E-01	1.75E-04	1.00E-01	1.75E-03
t-1,3-Dichloropropene	1.39E-03	1.28E-01	1.78E-04	3.00E-04	5.93E-01
Ethylbenzene	9.81E-02	1.28E-01	1.26E-02	1.00E-01	1.26E-01
Lead (Dissolved)	6.44E-03	1.28E-01	8.24E-04	ND	NA
Naphthalene	1.97E-02	1.28E-01	2.52E-03	4.00E-03	6.30E-01
Pentachlorophenol	2.44E-02	1.28E-01	3.12E-03	3.00E-02	1.04E-01
Petroleum Hydrocarbons	1.28E+01	1.28E-01	1.64E+00	ND	NA
Phenol	7.82E-03	1.28E-01	1.00E-03	6.00E-01	1.67E-03
Toluene	1.32E+00	1.28E-01	1.69E-01	2.00E-01	8.45E-01
Trichloroethylene	8.22E-03	1.28E-01	1.05E-03	ND	NA
Xylene	3.56E-01	1.28E-01	4.56E-02	2.00E+00	2.28E-02
Zinc (Dissolved)	2.85E-02	1.28E-01	3.65E-03	2.00E-01	1.82E-02
				HAZARD INDEX =	3E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.35
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.09E+00	3.49E-03	3.80E-03	2.90E-02	1.10E-04
Bis(2-ethylhexyl)phthalate	1.08E-01	3.49E-03	3.77E-04	1.40E-02	5.28E-06
1,1-Dichloroethane	1.37E-03	3.49E-03	4.78E-06	ND	NA
t-1,3-Dichloropropene	1.39E-03	3.49E-03	4.85E-06	1.80E-01	8.73E-07
Lead (Dissolved)	6.44E-03	3.49E-03	2.25E-05	ND	NA
Pentachlorophenol	2.44E-02	3.49E-03	8.52E-05	1.20E-01	1.02E-05
Trichloroethylene	8.22E-03	3.49E-03	2.87E-05	1.10E-02	3.16E-07
				CARCINOGENIC RISK =	1E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.36
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.09E+00	9.78E-03	1.07E-02	ND	NA
Bis(2-ethylhexyl)phthalate	1.08E-01	9.78E-03	1.06E-03	2.00E-02	5.28E-02
1,1-Dichloroethane	1.37E-03	9.78E-03	1.34E-05	1.00E-01	1.34E-04
t-1,3-Dichloropropene	1.39E-03	9.78E-03	1.36E-05	3.00E-04	4.53E-02
Ethylbenzene	9.81E-02	9.78E-03	9.59E-04	1.00E-01	9.59E-03
Lead (Dissolved)	6.44E-03	9.78E-03	6.30E-05	ND	NA
Naphthalene	1.97E-02	9.78E-03	1.93E-04	4.00E-03	4.82E-02
Pentachlorophenol	2.44E-02	9.78E-03	2.39E-04	3.00E-02	7.95E-03
Petroleum Hydrocarbons	1.28E+01	9.78E-03	1.25E-01	ND	NA
Phenol	7.82E-03	9.78E-03	7.65E-05	6.00E-01	1.27E-04
Toluene	1.32E+00	9.78E-03	1.29E-02	2.00E-01	6.45E-02
Trichloroethylene	8.22E-03	9.78E-03	8.04E-05	ND	NA
Xylene	3.56E-01	9.78E-03	3.48E-03	2.00E+00	1.74E-03
Zinc (Dissolved)	2.85E-02	9.78E-03	2.79E-04	2.00E-01	1.39E-03
				HAZARD INDEX =	2E-01

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.37
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.09E+00	1.17E-02	1.28E-02	2.90E-02	3.70E-04
Bis(2-ethylhexyl)phthalate	1.08E-01	1.17E-02	1.26E-03	1.40E-02	1.77E-05
1,1-Dichloroethane	1.37E-03	1.17E-02	1.60E-05	ND	NA
t-1,3-Dichloropropene	1.39E-03	1.17E-02	1.63E-05	1.80E-01	2.93E-06
Lead (Dissolved)	6.44E-03	1.17E-02	7.53E-05	ND	NA
Pentachlorophenol	2.44E-02	1.17E-02	2.85E-04	1.20E-01	3.43E-05
Trichloroethylene	8.22E-03	1.17E-02	9.62E-05	1.10E-02	1.06E-06
				CARCINOGENIC RISK =	4E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.38
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.09E+00	2.74E-02	2.99E-02	ND	NA
Bis(2-ethylhexyl)phthalate	1.08E-01	2.74E-02	2.96E-03	2.00E-02	1.48E-01
1,1-Dichloroethane	1.37E-03	2.74E-02	3.75E-05	1.00E-01	3.75E-04
t-1,3-Dichloropropene	1.39E-03	2.74E-02	3.81E-05	3.00E-04	1.27E-01
Ethylbenzene	9.81E-02	2.74E-02	2.69E-03	1.00E-01	2.69E-02
Lead (Dissolved)	6.44E-03	2.74E-02	1.76E-04	ND	NA
Naphthalene	1.97E-02	2.74E-02	5.40E-04	4.00E-03	1.35E-01
Pentachlorophenol	2.44E-02	2.74E-02	6.69E-04	3.00E-02	2.23E-02
Petroleum Hydrocarbons	1.28E+01	2.74E-02	3.51E-01	ND	NA
Phenol	7.82E-03	2.74E-02	2.14E-04	6.00E-01	3.57E-04
Toluene	1.32E+00	2.74E-02	3.62E-02	2.00E-01	1.81E-01
Trichloroethylene	8.22E-03	2.74E-02	2.25E-04	ND	NA
Xylene	3.56E-01	2.74E-02	9.75E-03	2.00E+00	4.88E-03
Zinc (Dissolved)	2.85E-02	2.74E-02	7.81E-04	2.00E-01	3.90E-03
				HAZARD INDEX =	6E-01

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 5.39
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.09E+00	6.70E-06	7.30E-06	2.90E-02	2.12E-07
Bis(2-ethylhexyl)phthalate	1.08E-01	6.70E-06	7.24E-07	1.40E-02	1.01E-08
1,1-Dichloroethane	1.37E-03	6.70E-06	9.18E-09	ND	NA
t-1,3-Dichloropropene	1.39E-03	6.70E-06	9.31E-09	1.80E-01	1.68E-09
Lead (Dissolved)	6.44E-03	NA (d)	NA	ND	NA
Pentachlorophenol	2.44E-02	6.70E-06	1.63E-07	1.20E-01	1.96E-08
Trichloroethylene	8.22E-03	6.70E-06	5.51E-08	1.10E-02	6.06E-10
				CARCINOGENIC RISK =	2E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.40
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.09E+00	7.82E-05	8.52E-05	ND	NA
Bis(2-ethylhexyl)phthalate	1.08E-01	7.82E-05	8.45E-06	2.00E-02	4.22E-04
1,1-Dichloroethane	1.37E-03	7.82E-05	1.07E-07	1.00E-01	1.07E-06
t-1,3-Dichloropropene	1.39E-03	7.82E-05	1.09E-07	3.00E-04	3.62E-04
Ethylbenzene	9.81E-02	7.82E-05	7.67E-06	1.00E-01	7.67E-05
Lead (Dissolved)	6.44E-03	NA (e)	NA	ND	NA
Naphthalene	1.97E-02	7.82E-05	1.54E-06	4.00E-03	3.85E-04
Pentachlorophenol	2.44E-02	7.82E-05	1.91E-06	3.00E-02	6.36E-05
Petroleum Hydrocarbons	1.28E+01	7.82E-05	1.00E-03	ND	NA
Phenol	7.82E-03	7.82E-05	6.12E-07	6.00E-01	1.02E-06
Toluene	1.32E+00	7.82E-05	1.03E-04	2.00E-01	5.16E-04
Trichloroethylene	8.22E-03	7.82E-05	6.43E-07	ND	NA
Xylene	3.56E-01	7.82E-05	2.78E-05	2.00E+00	1.39E-05
Zinc (Dissolved)	2.85E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	2E-03

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

TABLE 5.41
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.09E+00	1.91E-05	2.08E-05	2.90E-02	6.04E-07
Bis(2-ethylhexyl)phthalate	1.08E-01	1.91E-05	2.06E-06	1.40E-02	2.89E-08
1,1-Dichloroethane	1.37E-03	1.91E-05	2.62E-08	ND	NA
t-1,3-Dichloropropene	1.39E-03	1.91E-05	2.65E-08	1.80E-01	4.78E-09
Lead (Dissolved)	6.44E-03	NA (d)	NA	ND	NA
Pentachlorophenol	2.44E-02	1.91E-05	4.66E-07	1.20E-01	5.59E-08
Trichloroethylene	8.22E-03	1.91E-05	1.57E-07	1.10E-02	1.73E-09
				CARCINOGENIC RISK =	7E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.42
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.09E+00	4.46E-05	4.86E-05	ND	NA
Bis(2-ethylhexyl)phthalate	1.08E-01	4.46E-05	4.82E-06	2.00E-02	2.41E-04
1,1-Dichloroethane	1.37E-03	4.46E-05	6.11E-08	1.00E-01	6.11E-07
t-1,3-Dichloropropene	1.39E-03	4.46E-05	6.20E-08	3.00E-04	2.07E-04
Ethylbenzene	9.81E-02	4.46E-05	4.38E-06	1.00E-01	4.38E-05
Lead (Dissolved)	6.44E-03	NA (e)	NA	ND	NA
Naphthalene	1.97E-02	4.46E-05	8.79E-07	4.00E-03	2.20E-04
Pentachlorophenol	2.44E-02	4.46E-05	1.09E-06	3.00E-02	3.63E-05
Petroleum Hydrocarbons	1.28E+01	4.46E-05	5.71E-04	ND	NA
Phenol	7.82E-03	4.46E-05	3.49E-07	6.00E-01	5.81E-07
Toluene	1.32E+00	4.46E-05	5.89E-05	2.00E-01	2.94E-04
Trichloroethylene	8.22E-03	4.46E-05	3.67E-07	ND	NA
Xylene	3.56E-01	4.46E-05	1.59E-05	2.00E+00	7.94E-06
Zinc (Dissolved)	2.85E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-03

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 5.43
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM
GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	1.09E+00	5.43E-03	6.93E+01	8.3E-06	5.7E-04
1,1-Dichloroethane	1.37E-03	5.87E-03	9.41E-02	ND	NA
t-1,3-Dichloropropene	1.39E-03	2.43E-03	3.95E-02	3.7E-05	1.5E-06
Trichloroethylene	8.22E-03	1.03E-02	9.91E-01	1.7E-06	1.7E-06
				CARCINOGENIC RISK =	6E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 5.44
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	1.09E+00	5.43E-03	8.08E-01	ND	NA
1,1-Dichloroethane	1.37E-03	5.87E-03	1.10E-03	5.0E-01	2.20E-03
t-1,3-Dichloropropene	1.39E-03	2.43E-03	4.61E-04	2.0E-02	2.31E-02
Ethylbenzene	9.81E-02	8.44E-03	1.13E-01	1.0E+00	1.13E-01
Toluene	1.32E+00	5.94E-03	1.07E+00	2.0E+00	5.35E-01
Trichloroethylene	8.22E-03	1.03E-02	1.16E-02	ND	NA
Xylene	3.56E-01	5.10E-03	2.48E-01	3.0E-01	8.26E-01
				HAZARD INDEX =	1E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 5.45
SITE 1, FIRE TRAINING AREA
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	1.09E+00	5.43E-03	3.46E+02	8.3E-06	2.9E-03
1,1-Dichloroethane	1.37E-03	5.87E-03	4.70E-01	ND	NA
t-1,3-Dichloropropene	1.39E-03	2.43E-03	1.98E-01	3.7E-05	7.3E-06
Trichloroethylene	8.22E-03	1.03E-02	4.95E+00	1.7E-06	8.4E-06
				CARCINOGENIC RISK =	3E-03

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 5.46
SITE 1, FIRE TRAINING AREA
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	1.09E+00	5.43E-03	8.08E-01	ND	NA
1,1-Dichloroethane	1.37E-03	5.87E-03	1.10E-03	5.0E-01	2.20E-03
t-1,3-Dichloropropene	1.39E-03	2.43E-03	4.61E-04	2.0E-02	2.31E-02
Ethylbenzene	9.81E-02	8.44E-03	1.13E-01	1.0E+00	1.13E-01
Toluene	1.32E+00	5.94E-03	1.07E+00	2.0E+00	5.35E-01
Trichloroethylene	8.22E-03	1.03E-02	1.16E-02	ND	NA
Xylene	3.56E-01	5.10E-03	2.48E-01	3.0E-01	8.26E-01
				HAZARD INDEX =	1E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 5.47
SITE 1, FIRE TRAINING AREA
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Pathway Risk	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	2E-08	Benzene
	Dermal Absorption from Surface Soil	1E-07	Benzene
Future Onsite Workers	Incidental Ingestion of Deep Soils	2E-08	Benzene
	Dermal Absorption from Deep Soils	1E-07	Benzene
	Incidental Ingestion of Surface Soils	2E-08	Benzene
	Dermal Absorption from Surface Soil	1E-07	Benzene
	Ingestion of Groundwater	1E-04	Benzene
Future Adult Residents	Incidental Ingestion of Deep Soils	3E-08	Benzene
	Dermal Absorption from Deep Soils	5E-08	Benzene
	Ingestion of Groundwater	4E-04	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	3E-03	Benzene
	Dermal Absorption from Groundwate	7E-07	Benzene, Pentachlorophenol Bis(2-ethylhexyl)phthalate
	Incidental Ingestion of Surface Soils	3E-08	Benzene
	Dermal Absorption from Surface Soil	4E-08	Benzene
Future Children	Incidental Ingestion of Deep Soils	6E-08	Benzene
	Dermal Absorption from Deep Soils	9E-08	Benzene
	Ingestion of Groundwater	4E-04	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	6E-04	Benzene
	Dermal Absorption from Groundwate	2E-07	Benzene, Pentachlorophenol Bis(2-ethylhexyl)phthalate
	Incidental Ingestion of Surface Soils	5E-08	Benzene
	Dermal Absorption from Surface Soil	7E-08	Benzene

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TABLE 5.48
SITE 1, FIRE TRAINING AREA
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	2E-05	Ethylbenzene
	Dermal Absorption from Surface Soils	2E-04	Ethylbenzene
Future Onsite Workers	Incidental Ingestion of Surface Soils	2E-05	Ethylbenzene
	Dermal Absorption from Surface Soils	2E-04	Ethylbenzene
	Incidental Ingestion of Deep Soils	1E-03	Chromium, Naphthalene Zinc
	Dermal Absorption from Deep Soils	2E-03	Naphthalene
	Ingestion of Groundwater	2E-01	Bis(2-ethylhexyl)phthalate, t-1,3-Dichloropropene, Naphthalene, Toluene
Future Adult Residents	Incidental Ingestion of Surface Soils	3E-05	Ethylbenzene
	Dermal Absorption from Surface Soils	6E-05	Ethylbenzene
	Incidental Ingestion of Deep Soils	2E-03	Chromium, Naphthalene Zinc
	Dermal Absorption from Deep Soils	7E-04	Naphthalene
	Ingestion of Groundwater	6E-01	Bis(2-ethylhexyl)phthalate t-1,3-Dichloropropene Naphthalene, Toluene
	Inhalation of VOCs Released from Groundwater during Showering	1E+00	Xylene
	Dermal Absorption from Groundwater	1E-03	Bis(2-ethylhexyl)phthalate t-1,3-Dichloropropene Naphthalene, Toluene
Future Children	Incidental Ingestion of Surface Soils	3E-04	Ethylbenzene
	Dermal Absorption from Surface Soils	5E-04	Ethylbenzene
	Incidental Ingestion of Deep Soils	2E-02	Chromium, Naphthalene Zinc
	Dermal Absorption from Deep Soils	6E-03	Naphthalene
	Ingestion of Groundwater	3E+00	Bis(2-ethylhexyl)phthalate t-1,3-Dichloropropene Napthalene, Toluene
	Inhalation of VOCs Released from Groundwater during Showering	1E+00	Xylene
	Dermal Absorption from Groundwater	2E-03	Bis(2-ethylhexyl)phthalate t-1,3-Dichloropropene Napthalene, Toluene

TABLE 5.49

CHEMICAL CONSTITUENTS DETECTED AT SITE 1

AND CORRESPONDING ARARs

VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Benzene	1988	19	--	--	--
Bis(2-ethylhexyl)phthalate	1988	1.1	--	--	--
Chromium (VI)	1989	4.6	--	--	--
Copper	1989	10	--	--	--
Diethyl phthalate	1988	1	--	--	--
Ethylbenzene	1990	40	--	--	--
Lead	1988, 1989	100	--	--	--
2-Methylnaphthalene	1988	15	--	--	--
Naphthalene	1988, 1990	7.3	--	--	--
Nickel	1989	1.1	--	--	--
Tetrachloroethylene	1988	0.0009	--	--	--
Toluene	1988, 1989	37	--	--	--
TPH	1988, 1989	1,350	--	--	--
Trichloroehthylene	1988	0.041	--	--	--
Xylenes	1988	88	--	--	--
Zinc	1989	44	--	--	--
Groundwater (ug/L)					
Arsenic	1990	10.5	MCL/WIDNR	50	No
Benzene	1988, 1989, 1990	8,270	MCL/WIDNR	5	Yes
Bis(2-ethylhexyl)phthalate	1988	1,100	--	--	--
Copper	1989	13	WIDNR	1,000	No

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TABLE 5.49--Continued
CHEMICAL CONSTITUENTS DETECTED AT SITE 1
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
1,1-Dichloroethane	1988	12	WIDNR	850	No
trans-1,2-Dichloroethylene	1988	4.5	MCL/WIDNR	100	No
trans-1,3-Dichloropropene	1988	10	--	--	--
Diethyl phthalate	1989	12	--	--	--
2,4-Dimethylphenol	1988	4	--	--	--
Ethylbenzene	1988, 1990	535	MCL	700	No
Fluorene	1988	3	--	--	--
Lead	1989	270	MCL	15	Yes
2-Methylnaphthalene	1990	38	--	--	--
Naphthalene	1988, 1990	92	--	--	--
Nickel	1990	11.4	--	--	--
Pentachlorophenol	1988, 1990	76	MCL	1	Yes
Phenol	1988	28	--	--	--
TDS	1989, 1990	550,000	--	--	--
Toluene	1988, 1989, 1990	12,700	WIDNR	343	Yes
TPH	1988, 1990	110,000	--	--	--
1,1,1-Trichloroethane	1988	60	MCL/WIDNR	200	No
Trichloroethylene	1988, 1989, 1990	79	MCL/WIDNR	5	Yes
Xylenes	1988, 1989, 1990	1,800	WIDNR	620	Yes
Zinc	1989, 1990	87	MCL/WIDNR	5,000	No

MCL - Safe Water Drinking Act Maximum Contaminant Level.
WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.

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SECTION 6
SITE 2 - FORMER LANDFILL C

BACKGROUND

A site description, history, and a summary of field activities for Site 2 is provided in this subsection.

Site Description

Site 2 is located in the southeastern corner of the Base approximately 600 feet southeast of South Perimeter Road as shown on Figure 6.1. The site is an abandoned landfill elevated above the surrounding natural grade which is heavily wooded and swampy. The landfill is covered with grass and sparse underbrush in most areas although some debris remains uncovered along the edges of the landfill. A rusty stain on the standing water to the southwest of the landfill indicates a possible leachate seep.

Site History

The Base began using Former Landfill C in 1954. Materials reportedly placed in this landfill include general municipal waste, construction materials, paint thinners, lab chemicals, oil, solvent-contaminated sweeping compounds, degreasing solvents, ethylene glycol, waste oils and other automotive fluids. In addition, various empty containers of paint, thinners, pesticides, batteries, small arms ammunition and other munitions (possibly including napalm) reportedly have been buried here [HMTC, 1984]. The landfill has not been utilized since June 1984.

1987 Field Activities

Work performed during the 1987 field investigation included a geophysics survey, monitoring well installation and groundwater sampling. Eight metals and one semivolatile organic were detected in the groundwater samples obtained during this investigation [ES, 1990c]. The analytical data obtained during this investigation is presented in Appendix G. Further work was required to characterize the hydrogeology at this site.

1989 Field Activities

Work performed at Site 2 during the 1989 RI was limited to monitoring well installation. One intermediate-depth well (MW-5) was installed downgradient of the landfill boundary near well MW-3. MW-5 was installed to define the vertical gradient at this site. It was screened at depths from 50 to 60 feet. Monitoring well

MW-5 was surveyed after the drilling activities were completed; the location of MW-5 is indicated on Figure 6.1.

An attempt was made to measure groundwater levels on December 13, 1989. Ice was found in the risers of two of the shallow wells due to water levels that had risen above ground level and frozen. The cap on a third well had frozen to the casing and could not be removed. Thus, groundwater levels were not measured in 1989.

1990 Field Activities

Field activities performed in 1990 included soil boring, exploratory hand-augering and sampling of groundwater, surface water and soils.

Five shallow hand augered borings were completed to collect surficial soil samples for analysis. These data were collected to complete the risk assessment. Four of the borings were located at the landfill and one background boring was located northwest of the landfill off South Perimeter Road (Figure 6.1). Each boring was terminated at a maximum depth of 2 feet. Soil samples were analyzed for purgeable aromatic hydrocarbons, purgeable halocarbons, TPH, pesticides and PCBs, semivolatiles and metals.

Exploratory hand augering was also performed at this site to determine the thickness of the landfill cover. The location of the thirteen exploratory hand augered borings is shown on Figure 6.1. The hand auger was advanced to depths of 1 to 3 feet. No analytical samples were obtained.

Groundwater samples were obtained from all monitoring wells and analyzed for halogenated and aromatic volatile organics, semivolatile organics, TPH, pesticides/PCBs, metals, TDS and field parameters (pH, specific conductance, and temperature).

Surface water samples were collected from four stations at this site (Figure 6.1). Three stations are located in the perennial stream that runs north to south along the eastern border of the site. One station is located in the swamp south of the landfill where an orange stain was observed. All surface water samples were analyzed for the same parameters as the groundwater samples. Streamflow measurements using a Swoffler® velocity meter, were attempted at surface water sampling station 1. This area of the stream appeared to have the most water movement; however, an accurate streamflow could not be determined due to the low flow rate.

Groundwater measurements were obtained at all monitoring wells at the beginning of the 1990 field investigation and again after ES field activities were completed. The five soil borings and four surface water sampling stations were surveyed for horizontal location and elevation. The two cluster wells at this site were also resurveyed.

1991 Field Activities

Field activities in 1991 included sediment sampling and the measuring of groundwater elevations.

Four sediment samples were obtained from the locations depicted on Figure 6.1. The sediment samples were analyzed for semivolatile organics, pesticides/PCBs and 13 priority pollutant metals. These samples were collected to fill a potential data gap identified during preparation of the risk assessment for this site.

Groundwater elevations were measured on 30 October 1991 at all monitoring wells.

RESULTS

The results of the field investigations are presented in this subsection.

Geology/Hydrogeology

The lithologies encountered during exploratory augering and soil borings consisted of moist, fine silty sands of Pleistocene age with occasional thin layers of clay. Cambrian sandstone was encountered in well MW-5 at a depth of approximately 50 feet. The hydrogeology of Site 2 is presented in the location map on Figure 6.2 and the cross-section on Figure 6.3. Soil boring and well construction logs are presented in Appendix B.

Hydrogeologic investigations confirm there are two components of groundwater flow at this site: vertical (upward) and horizontal (east-southeast). Groundwater elevations measured on 13 November 1990 indicate flow in the Pleistocene sand is toward the east-southeast with an average hydraulic gradient of 0.0008 ft/ft (Figure 6.1). A slight upward component of flow is also indicated by the elevation data between well MW-5 and MW-3 (Figure 6.3). Elevation data and well construction details are presented in Table 2.4. A complete summary of the groundwater measurements is presented in Appendix B.

Water elevations measured at the two cluster wells (MW-5 and MW-3) show the groundwater flow potential is upward from the sandstone to the sands with a vertical hydraulic gradient of 0.0037 ft/ft. This upward gradient and the fact that the potentiometric surface is above or at the ground surface downgradient of Site 2 implies this is a groundwater discharge area. Discharge areas are often represented by swampy or marshy conditions as seen in the area surrounding Site 2. Results of the hydrogeologic investigation at this site indicate the potential for contaminant migration to great depths is very unlikely due to the upward gradient and the site proximity to a groundwater discharge area.

A groundwater flow velocity of 0.2 ft/day or 78 ft/yr has been estimated in the Pleistocene sand at this area. The flow velocity is based upon a hydraulic

conductivity of 40.0 gpd/ft^2 or 5.3 ft/day (estimated from 1988 slug tests) [ES, 1990c], a hydraulic gradient of 0.008 ft/ft and an effective porosity of 0.2 [Bouwer, 1978].

Soil Sampling Results

Thirteen hand auger borings were advanced to 3 feet or until landfill material was encountered. Figure 6.4 depicts the boring locations, depths and unearthed debris at each location. The four borings in the northern lobe of the landfill encountered debris within the top 2 feet. The remaining nine borings were augered into the cap on the southern lobe of the landfill. Four of these borings were advanced to 3 feet; two borings encountered debris at 3 feet. The southern lobe had a minimum of 1.5 feet of cover material over the debris. Hand augered borings were not advanced in the area between the northern and southern lobes of the landfill. Part of this area is a sandstone outcrop and the rest of the area is at the same elevation as the surrounding terrain. The northern and southern borders of this area slope upward to their respective lobes. An exploratory hand auger summary is provided in Appendix B.

Four soil samples from the landfill cap and a fifth background soil sample were collected and analyzed. Analytical results are summarized in Table 6.1. In the background sample, collected from boring SB-5, the following three metals were detected: chromium at 1.2 mg/kg, copper at 1.2 mg/kg and zinc at 4.6 mg/kg. The metals concentrations in the four samples collected from the landfill were similar to background concentrations. Zinc and lead were found at levels slightly higher than background in samples collected from borings SB-1 and SB-2. None of these concentrations exceed any potential guidance criteria for metals in soils.

Ten semivolatile compounds were detected in the soils from SB-2 at concentrations ranging from 0.180 to 0.590 mg/kg. Samples from SB-1 and SB-4 contained five and three semivolatiles, respectively. All of the detected semivolatiles are PAHs for which no ARARs were identified.

SB-2 was shown to contain one pesticide, DDT, at an estimated concentration of 0.022 mg/kg. Four pesticide related chemicals, dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyltrichloroethane (DDT) and Chlordane, were detected in the sample from SB-1. The concentrations of DDE and DDT were estimated at 0.017 and 0.028 mg/kg, respectively. DDE was detected at 0.038 mg/kg and Chlordane was tentatively identified at 0.084 mg/kg. These concentrations are below any appropriate criteria.

Xylene was the only volatile organic detected. It was found at an estimated concentration of 0.0091 mg/kg in the sample collected from SB-4. This concentration is below any potential ARARs.

Sediment Sampling Results

A total of seven metals ranging in concentration from 0.16 to 1,000 mg/kg were detected in the sediment samples (Table 6.2). All these metals except cadmium were detected in the upstream sediment sample (SD-2 on Figure 6.1). Prior to sediment sampling, cadmium was not detected in any medium at Site 2. The highest metals concentrations in the sediments were detected in the sample from SD1 located approximately 120 feet north of the northern lobe of the landfill (Figure 6.1). Arsenic, mercury and lead were found at 15.9, 0.24 and 72.5 mg/kg. Cadmium was detected at 5.4 mg/kg. Chromium and copper levels were less than 25 mg/kg and zinc was detected at 1,000 mg/kg. One semivolatile organic, benzoic acid, at an estimated concentration of 2.1 mg/kg was found in the sample obtained from SD2. No organochlorine pesticides or PCBs were detected in these sediment samples. No guidance criteria are exceeded for any contaminant detected in the sediments at this site.

Groundwater Sampling Results

Groundwater was analyzed for halogenated volatiles, aromatic volatiles, semivolatiles, TPH, pesticides/PCBs, dissolved metals and TDS. Total dissolved solids were found in concentrations from 14 to 68 mg/L. No other chemical constituents were found in these groundwater samples (Table 6.3).

One semivolatile organic and eight metals were detected in groundwater samples obtained at Site 2 in 1988 (Appendix G.) [ES 1990c]. Bis(2-ethylhexyl)phthalate was thought to have been introduced during sampling or as a laboratory contaminant and was not considered to be associated with contamination at the site. The presence of metals in the 1988 groundwater samples and not in the 1990 samples may be because the earlier samples were unfiltered, and the metals in the 1988 samples is, therefore, due to the presence of metals in particulate/soil materials that were not removed (by filtration) from the groundwater samples. None of the metals concentrations in groundwater samples from either sampling event exceed current drinking water criteria.

Surface Water Sampling Results

The same organic analyses conducted on the groundwater samples were also performed on the surface water samples. No organics were detected in the five surface water samples (Table 6.4). Zinc, mercury and lead were found at very low levels in both the upgradient and downgradient samples. Total dissolved solids were detected in all five samples at concentrations between 130 and 520 μg/L.

BASELINE RISK ASSESSMENT

The following subsections present the Site 2 risk assessment. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the baseline risk assessment. The risk assessment presented here was

conducted according to the most recent EPA guidelines and considers all of the available site monitoring data through 1991. These risk assessment procedures are outlined in Section 4.

Selection of Chemicals of Concern

Metals, pesticides, semivolatile organics and one volatile organic compound were detected in soils, groundwater, surface water and sediments associated with Site 2. Based on the chemicals detected in 1988 (Appendix G), 1990 and 1991 rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected for each medium. Metals data for groundwater from the 1988 sampling effort were unfiltered and therefore, not considered in the risk assessment. Both filtered and unfiltered surface water data was used, however. The available toxicity information for the chemicals of concerned in the risk assessment at this site is provided in Section 4 and Appendix F.

Surface Soils

Pesticides, PAHs, xylene, and metals were retained as chemicals of concern for surface soils associated with Site 2. The arithmetic average, standard deviation, and maximum detected concentration for each chemical are presented in Table 6.5. Mercury and nickel were detected in surface soils but were not retained as chemicals of concern since their concentrations were not greater than three times the minimum background concentration for soils (Table 4.5).

Groundwater

No chemicals were detected in groundwater; therefore, no chemicals of concern were selected for groundwater.

Surface Water

Copper, lead, mercury, thallium and zinc were detected in surface water at Site 2. Of these, zinc, mercury and lead were retained as chemicals of concern and are presented with the arithmetic average, standard deviation and 95 percent UCL of the arithmetic average for each metal in Table 6.6. Copper and thallium were not retained because they were only found in the upstream location.

Sediments

Seven metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury and zinc) were detected in site sediment samples. Cadmium, chromium, copper, arsenic, and mercury were not retained as chemicals of concern because their concentrations did not exceed three times the corresponding upstream sediment concentrations. The arithmetic average, standard deviation, and the 95 percent UCL of the arithmetic averages for lead and zinc are given in Table 6.7.

Human Health Evaluation

The human health evaluation is provided in the following subsections.

Exposure Pathways

Potential sources for contaminant release at this site include soils or sediments in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 2 are surface soils, sediments and surface water at the site. Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point.

Access to Site 2 is not controlled, but the site is in a remote area and is surrounded by swampy land. There is a gate across the dirt road which leads into the landfill area. Based upon this setting, the only people expected to enter the site would be hunters or onsite Base workers engaged in maintenance-related activities. Children who live near the Base are unlikely to wander onto the Base to play at Site 2. Hypothetical (future) human receptors selected for this site include: onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 2 are summarized in Table 6.8.

Soils. Current pathways involving incidental ingestion of and dermal contact with surface soils at Site 2 are unlikely but possible for onsite workers. In the unlikely event that a residence was constructed at Site 2, both oral and dermal contact with soils by hypothetical residents would be more likely to occur.

Groundwater. Private water supply wells are located more than one mile downgradient (southeast) of Site 2; however, contaminants were not detected in monitoring wells immediately downgradient of Site 2. Therefore, groundwater pathways are not considered further in this assessment.

Surface Water. Site 2 lies within the Little Lemonwier River drainage basin. A perennial stream runs north to south along the eastern border of the site and a swampy area is located south of the landfill. Zinc, mercury, and lead were found at very low levels in both upgradient and downgradient samples. Exposure to these metals could occur during recreational use of the site (e.g., during hunting). To assess this potential exposure pathway, incidental ingestion of the surface water (such as during swimming) was assessed. This conservative approach was chosen simply to determine if a health risk might exist and was intended to reflect any actual/potential exposures.

Air. Xylene was detected in soil samples taken from Site 2 and exposure via inhalation of xylene released to the air could occur. Current exposures would be primarily to site visitors (hunters and onsite workers), nearby residents, and Base personnel in areas downwind of the site. Given the low concentration of xylene present in soils, the xylene concentrations in air would also be quite low. Similarly, exposures via inhalation of inorganic and semivolatile organic contaminants released to air via wind erosion of surface soils could occur; however, the landfill cover and vegetation serve to retard wind erosion and thus limit potential exposures.

Exposure to contaminants released to air from soils was not quantified since the risks associated with these pathways would be orders of magnitude lower than those associated with oral and dermal exposure.

In this assessment, exposure concentrations, exposure intakes (oral and dermal pathways only), and subsequent risks and hazard indices were calculated for the following pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of surface soils	Children	6.9	6.10
	Workers	6.11	6.12
	Adult residents	6.13	6.14
Dermal contact with surface soils	Children	6.15	6.16
	Workers	6.17	6.18
	Adult residents	6.19	6.20
Ingestion of surface water(1)	Children	6.21	6.22
	Adult residents	6.23	6.24
Ingestion of sediments	Children	6.25	6.26
	Adult residents	6.27	6.28

(1) Scenario for exposure by this pathway involves routine incidental ingestion of small quantities of surface water. This scenario is more applicable to exposure during swimming but was used as a conservative estimate of health risks at this site for surface water pathways.

Risk Characterization

Carcinogenic Risks

A summary of the carcinogenic risks for each receptor and pathway is provided in Table 6.29. The calculated risks for each environmental medium and exposure pathway are discussed below.

Soils. Carcinogenic risks were evaluated for two exposure pathways associated with surface soil contamination at this site. These exposure pathways involve

ingestion and dermal absorption of the chemicals detected in the surface soils. Carcinogenic risks for all soil exposure pathways and receptors were within EPA's target risk range of one-in-one million (1E-06) to one-in-ten-thousand (1E-04). Thus, even though a relatively conservative set of assumption was used in this assessment (i.e., residential use of the site), the calculated carcinogenic risks for soil pathways at Site 2 do not indicate unacceptable health risks are currently present or will occur in the future.

Surface Water. Lead was the only carcinogenic compound detected in surface water. Risks associated with exposure to lead cannot be quantitatively assessed because there is no slope factor for lead. However, lead concentrations detected in site surface water can be qualitatively assessed by comparing detected lead levels to the State of Wisconsin Human Threshold Criteria for protection of human health (50 $\mu g/L$). The only detected concentration of lead in a downstream sample was 22 $\mu g/L$. Because the detected lead concentration is less than one-half the federal criteria, an unacceptable carcinogenic risk for future human receptors is not likely.

Sediments. Carcinogenic risks for all sediment exposure pathways and receptors were below EPA's target risk range. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., routine incidental ingestion of sediments), the calculated carcinogenic risks for sediment pathways at Site 2 do not indicate unacceptable health risks are currently present or will occur in the future.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was also assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 6.30. A hazard index which exceeds 1 is an indication that adverse health effects are likely. The hazard index for each environmental medium and exposure pathway are discussed below.

Soils. Noncarcinogenic risks were evaluated for two exposure pathways associated with surface soil contamination at this site. These exposure pathways involve ingestion and dermal absorption of the chemicals detected in the surface soils. All calculated hazard indices for these pathways and for potential receptors were less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment, the calculated hazard indices for soil pathways at Site 2 do not indicate that noncarcinogenic health risks currently exist or are possible in the future.

Surface Water. The hazard indices for the surface water exposure pathway and receptors were much less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., incidental ingestion such as during swimming), the calculated hazard indices for surface water exposure pathways at

Site 2 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Sediments. The hazard indices for all sediment exposure pathways and receptors were less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated hazard indices for sediment pathways at Site 2 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Ecological Evaluation

Site 2 is surrounded by wetland areas characterized by bottomland hardwoods and lowland brush. Ecological receptors supported by these habitats are summarized in Section 4.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 2 could include:

- ingestion and dermal contact with contaminants in soils by animals, particularly for burrowing species;
- uptake of contaminants in soils by plants;
- ingestion and dermal contact with contaminants present in surface runoff from the site by terrestrial and avian species;
- uptake of contaminants in surface runoff by plants;
- inhalation of VOCs released from contaminated soils by terrestrial and avian species; and
- ingestion of contaminated plants or animals.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is vegetated. Inhalation exposures resulting from xylene released from soils is unlikely due to the low concentration of xylene in soils.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in soils. Available toxicity values used to evaluate compounds detected in surface water and soils associated with Site 2 are presented in Table 4.10. These values include water quality criteria for the protection of freshwater aquatic life and acute oral LD50s for mammals. There are no similar criteria for plants or birds. It should be noted that these values can be used only in a qualitative way to determine which detected contaminants may have adverse ecological impacts. Acute LD50 values can only be used to highlight which of the detected chemicals might be toxic to mammals and similarly the water quality criteria could be used to highlight which detected contaminants might be toxic to aquatic organisms.

Risk Characterization

Lead, mercury and zinc were retained as chemicals of concern in surface water samples. Detected concentrations of lead and mercury exceed the chronic water quality criteria for the protection of freshwater aquatic life (Table 4.10). Lead is also severely toxic to mammals and can be toxic to terrestrial plants in acidic soils.

A method of screening the relative toxicity of a chemical in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils. Lead, chromium, and chlordane are the only chemicals of concern for site soils which are severely toxic to mammals. DDT, pyrene, copper and zinc are classified as moderately toxic, while xylene and the remainder of the PAHs are slightly toxic to mammals with respect to acute oral toxicity.

DDT and its associated metabolites are known to be toxic to avian species. Because all raptors (birds of prey) are protected by law, the raptor species listed as occurring onsite in the Integrated Land Use Management Plan (ILUMP) were evaluated as a group at risk from DDT. For the purpose of pathway analysis and risk assessment, these raptor species were further categorized into terrestrial and aquatic groups. The turkey vulture, hawks, owls, and falcons listed in the ILUMP prey primarily on small mammals, carrion, birds, and insects and can be categorized as a terrestrial group of raptors. The bald eagle preys primarily on fish and waterfowl and is classified in the aquatic raptor group.

Published studies examining the potential impacts to raptors from DDT in the soil are not available. However, several studies have been conducted that examine the effects to raptors from DDT in prey. Data from these latter studies were used in conjunction with DDT concentrations detected onsite and site characterization information to determine risks to raptors from DDT at this site. DDT is stable in soil under natural environmental conditions (Sax, 1985), but it may be transformed to DDE and DDD under certain conditions.

In general, potential toxic effects of DDT to raptors are high. DDT is known to accumulate in the fat of fish and mammals. However, it has been reported that avian prey, especially insectivorous species, are generally more contaminated with DDE than reptilian or mammalian prey (Snyder et al., 1972). DDE is generally considered to accumulate in the tissues of birds in higher concentrations than DDD or DDT (Porter and Wiemeyer, 1972).

Results of research studies indicate the maximum DDT concentration (0.028 mg/kg) detected in site soils should not present an unacceptable risk to raptors (including the bald eagle) because the DDT is relatively immobile in the soil (McCall et al., 1980) and should not biomagnify from the soil through the food chain of local raptors. In addition, based on the soil boring locations and the site map in the ILUMP, it does not appear that this site is in or adjacent to aquatic

environments where bald eagles would likely be foraging. The site appears to be an upland area and is more likely to be utilized by species of the terrestrial raptor group listed above.

It is noted DDE strongly biomagnifies in aquatic food chains, and DDT was detected in soil samples from Site 2. Therefore, sediment samples were taken to determine if additional risks potentially exist for raptors due to the presence of DDT and its degradation products. DDT, DDE, and DDD were not detected in these sediment samples. Therefore, potential risks to the bald eagle through biomagnification in the aquatic food chain appear to be very low.

In conclusion, the risk to bald eagles from DDT at Site 2 appears low based on the following:

- DDT was not detected in sediment samples from Site 2;
- DDT was detected only at low concentrations in soil;
- DDT is relatively immobile in soil; and
- there is a substantial distance between the contaminated areas and the aquatic areas having a forage base for bald eagles.

Risk Assessment Conclusions

This subsection provides the conclusions and uncertainties of the baseline risk assessment.

Human Receptors

Volatiles, semivolatiles, pesticides, and inorganics were detected in surface soils at Site 2. No contaminants of concern were detected in groundwater associated with the site. The only current human exposure pathways which could occur are incidental ingestion of and dermal contact with surface soils by onsite workers. Hypothetical future pathways at the site include ingestion of and dermal contact with contaminants in soils for onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site. Inhalation pathways associated with xylene, semivolatiles, and zinc in surface soils are possible but were not calculated because the risks associated with these pathways are expected to be orders of magnitude lower than those associated with the oral and dermal pathways. Ingestion of surface water was also considered for hypothetical (future) residents.

No unacceptable risks associated with contaminants in soils and surface water at Site 2 were found. It should be noted that any potential risks associated with lead were not quantified in this assessment due to the lack of generally accepted/approved reference toxicity values. The risks associated with lead in soils at Site 2 are expected to be very low since the concentrations detected are well below the EPA's target lead concentration (500 mg/kg) for lead in soils at

Superfund sites [EPA, 1989b]. This target concentration was based on multi-route exposure to lead-contaminated soils, given a blood lead level of concern of 10 to 15 $\mu g/dl$. The risk associated with lead in surface water is also expected to be low since the concentration detected is below the federal water quality criterion.

A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4. An important assumption made in this risk assessment is that contaminant concentrations will remain constant and not decrease over a long period of time, up to 30 years. However, organic compounds detected in soils do degrade with time. This would result in an overall decrease in contaminant concentrations.

Another uncertainty in the characterization of risks associated with Site 2 concerns the possible presence of benzene in surface soils. Although not presented in the discussion of results for soil sampling, benzene was detected at a concentration of 14 $\mu g/kg$ in one sample during the first column analysis; however, since the holding time was exceeded by a wide margin for the second column, benzene was flagged "UR" for that sample (Appendix E). However, this observation has little impact on the conclusions drawn from the risk assessment because the presence of benzene in surface soils at a concentration of 14 $\mu g/kg$ would not have a significant impact on the cancer risk values or hazard indices associated with soil pathways.

Ecological Receptors

Ecological receptors could be exposed through uptake of chemicals detected in soils and surface water. It is not possible to characterize risks associated with contaminants detected at Site 2 for ecological receptors due to the lack of reference toxicity information. Based on reference values for acute exposure, lead, chromium and chlordane are the only chemicals of concern in soils which are severely toxic to mammals. Based on water quality criteria, lead and mercury in surface drainage could have an impact on aquatic life. DDT, which was detected in surface soil samples is known to be toxic to birds. The risk to bald eagles from DDT at Site 2 appears low based on the following:

- DDT was not detected in the sediment samples from Site 2
- DDT was detected only at low concentrations in soil
- DDT is relatively immobile in soil
- there is a substantial distance between the contaminated areas and the aquatic areas having a forage base for bald eagles.

CONCLUSIONS

The cap on the northern lobe of the landfill is incomplete and varies in thickness from 0 to 2 feet. Various hardfill materials are exposed over portions of

the northern lobe. The southern lobe has a soil cap ranging from 1.5 feet to greater than 3 feet in depth. No landfill material is present at the ground surface of the southern lobe; however, it is evident on the sides of the landfill.

The only organic compound detected in the groundwater samples collected at this site was bis(2-ethylhexyl)phthalate, which was detected in the upgradient well. Several inorganic compounds were detected in unfiltered groundwater samples. Only inorganics were detected in the sediments and surface water samples collected. PAHs and pesticides were detected in soil samples collected from borings advanced into the top of the landfill.

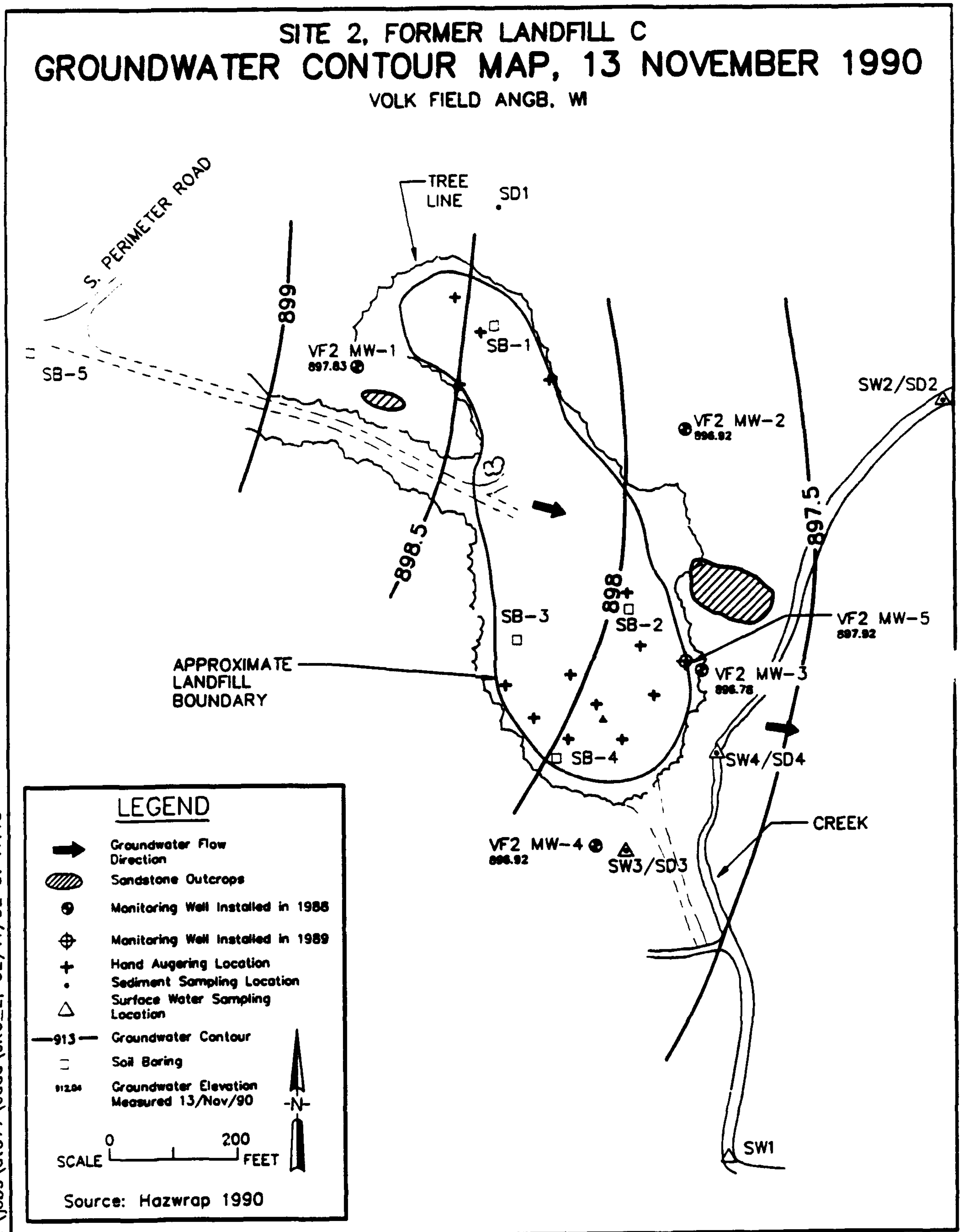
The compounds detected in surface water, groundwater, soils and sediments at Site 2, including those detected during the 1988 sampling effort [ES, 1990c], are presented in Table 6.31. This table also provides a comparison of the maximum detected concentrations to the ARARs introduced in Tables 4.1 through 4.4. ARARs exceeded at this site include federal criteria for protection of freshwater aquatic life and the Wisconsin surface water criteria, both for surface waters. Compounds detected in surface water which exceeded ARARs include lead, mercury, thallium and zinc. However, each of these metals was present in an upstream location and is not thought to be present as a result of activities at this site. Criteria for groundwater were not exceeded. ARARS for soil and sediment were not identified, however, To-Be-Considered criteria for these media are presented in Section 4.

The pathways for exposure considered at Site 2 included the incidental ingestion of surface soils, dermal contact with surface soils, ingestion of sediments and ingestion of surface waters. All carcinogenic and noncarcinogenic risks were found to be acceptable. Therefore, no adverse health effects are expected to occur at this site.

RECOMMENDATIONS

Site 2 has been sufficiently investigated to conclude that the landfill does not present an unacceptable risks to human receptors. The risks to ecological receptors from lead and DDT at Site 2 appear low. It is, therefore, recommended that a No-Further-Action Decision Document be prepared for this site.

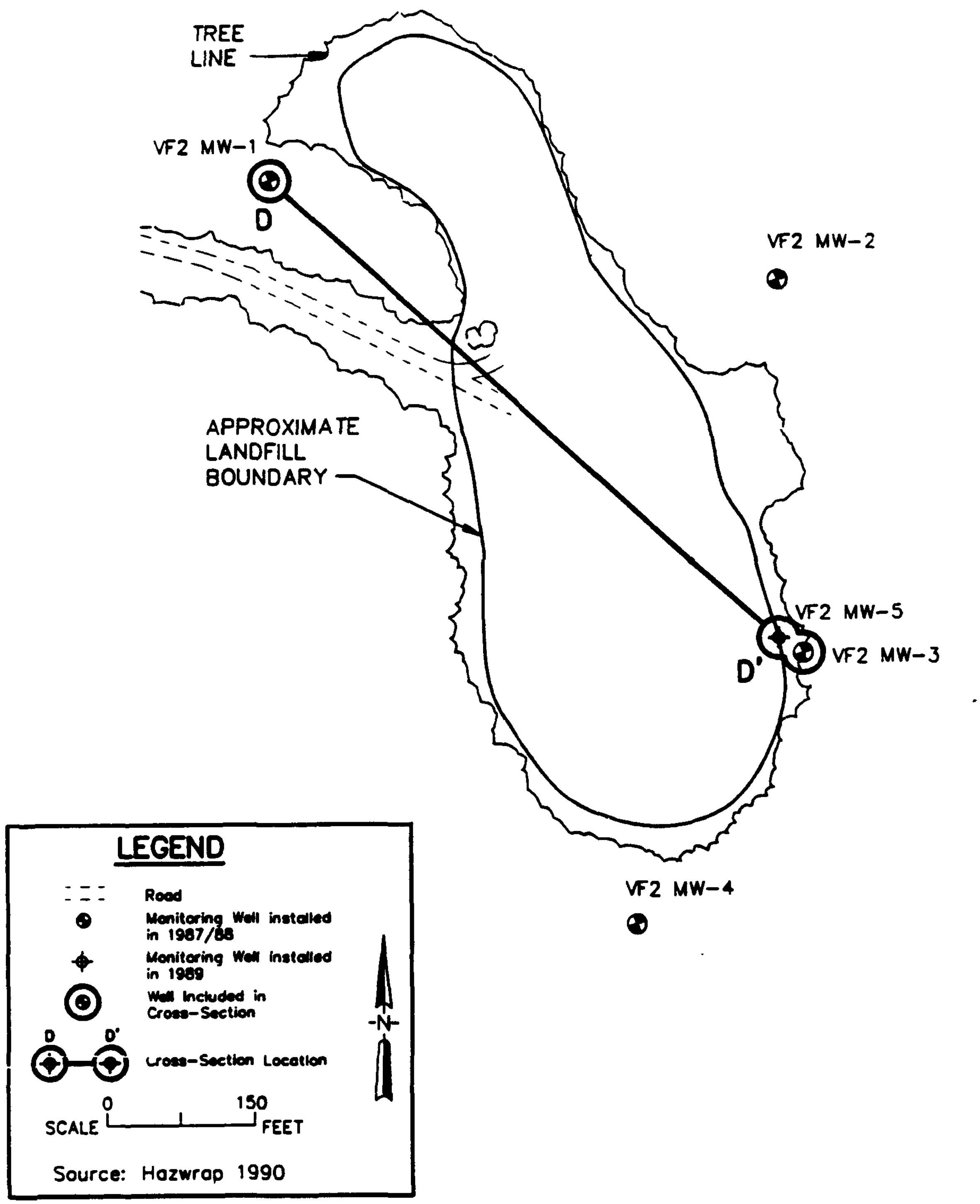
Figure 6.1



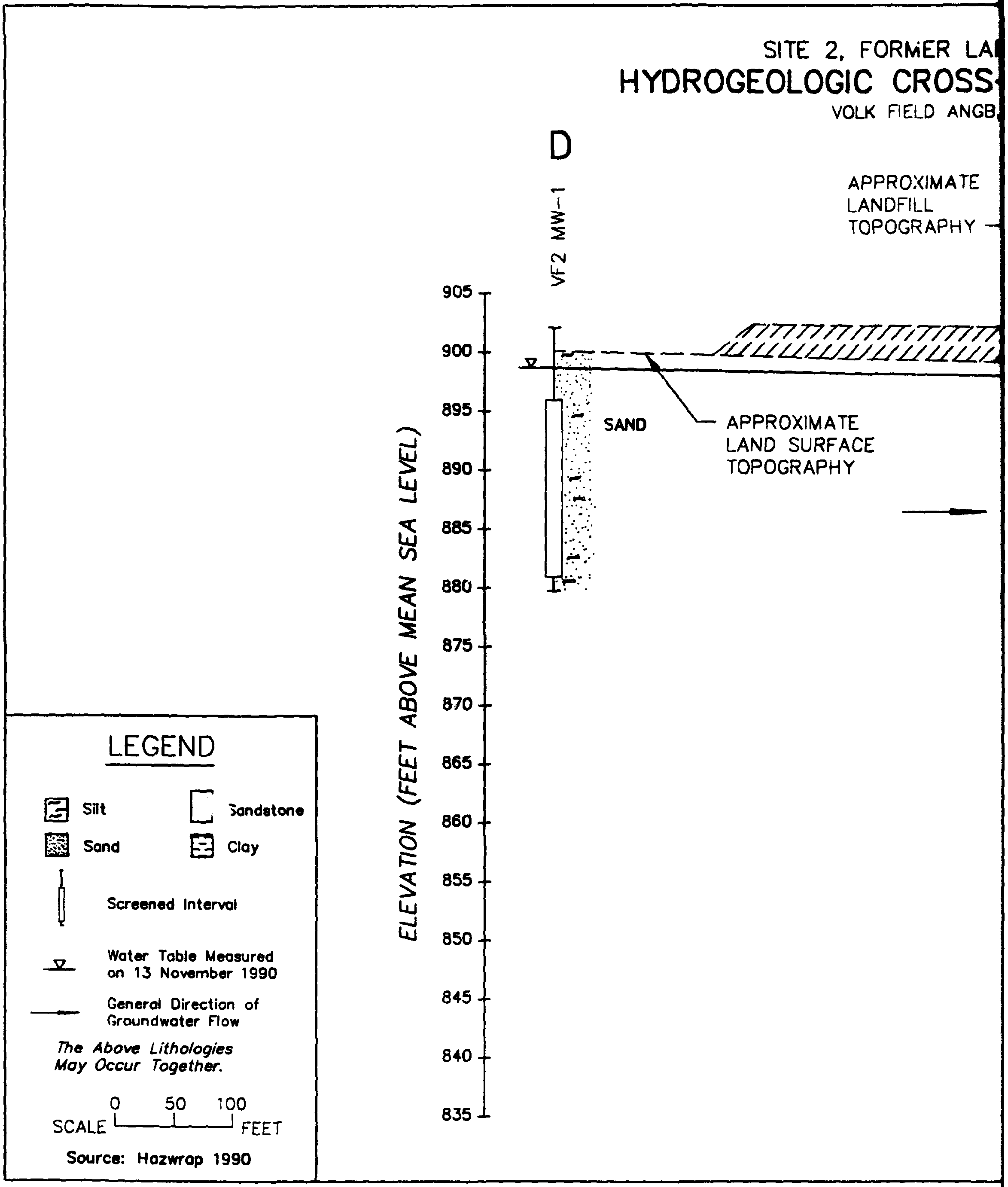
ENGINEERING-SCIENCE

Figure 6.2

SITE 2, FORMER LANDFILL C
HYDROGEOLOGIC CROSS-SECTION LOCATION
VOLK FIELD ANGB, WI



at077\crossd-d, 06/12/91 at 15:46



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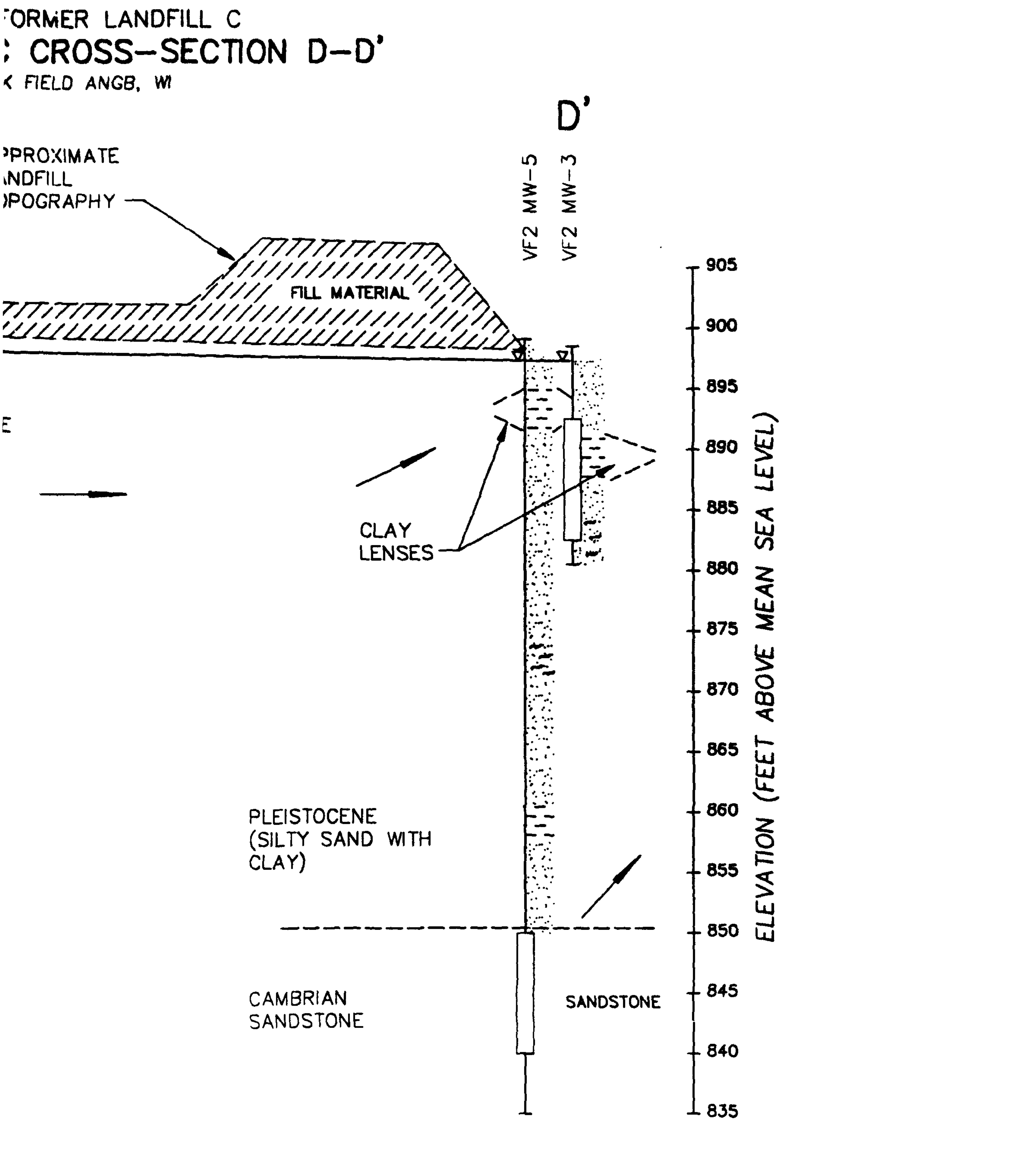
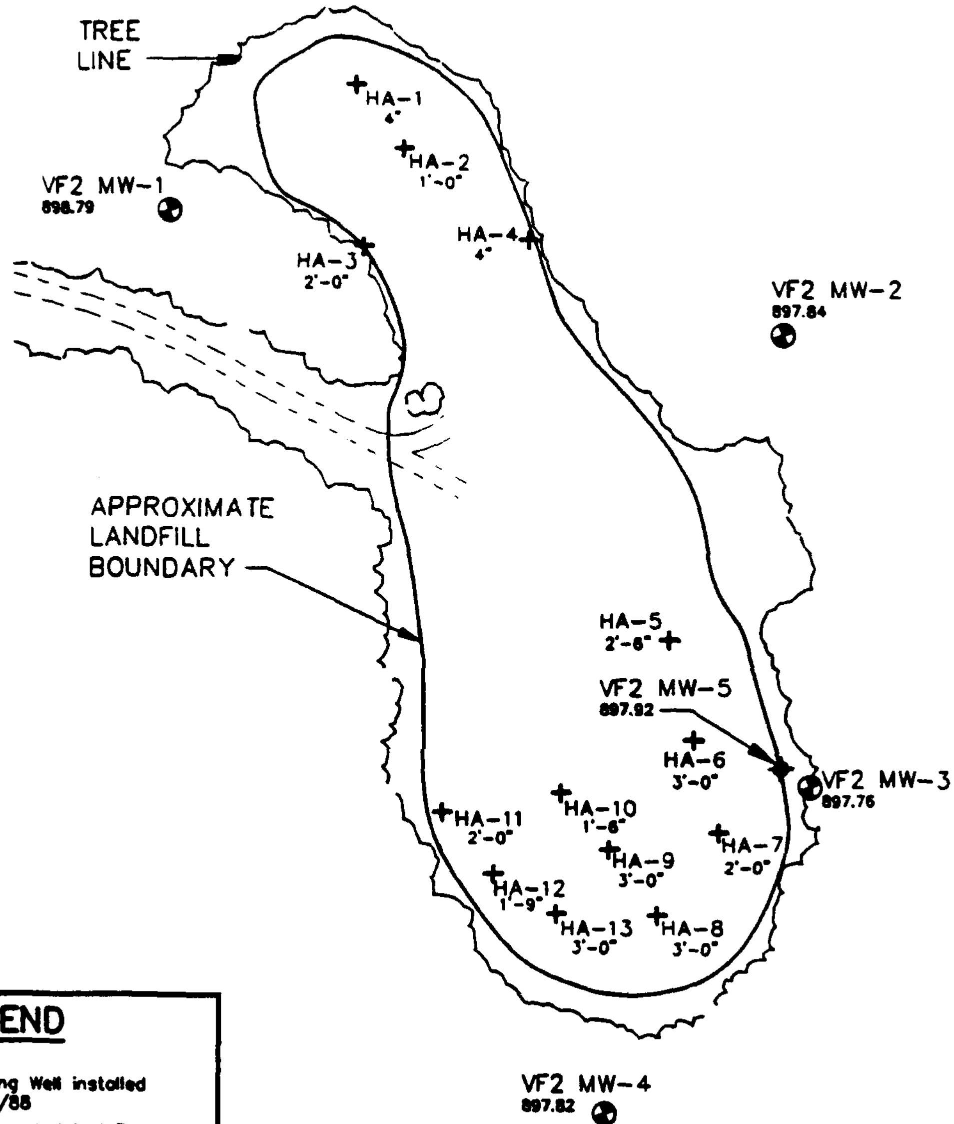
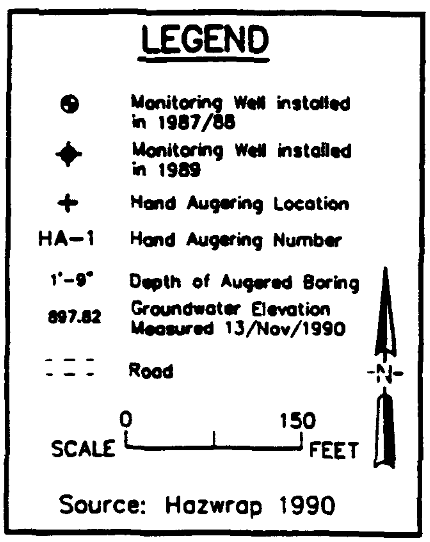

'ORMER LANDFILL C
; CROSS-SECTION D-D'
‹ FIELD ANGB, WI
D'
'PPROXIMATE
ıNDFILL
)POGRAPHY
FILL MATERIAL
VF2 MW-5
VF2 MW-3
CLAY
LENSES
PLEISTOCENE
(SILTY SAND WITH
CLAY)
CAMBRIAN
SANDSTONE
SANDSTONE
905
900
895
890
885
880
875
870
865
860
855
850
845
840
835
ELEVATION (FEET ABOVE MEAN SEA LEVEL)

Figure 6.4

SITE 2, FORMER LANDFILL C
LANDFILL CAP THICKNESS
VOLK FIELD ANGB, WI





AUGER #	DEPTH	DISCOVERY
HA-1	4"	AL FOIL, FOAM RUBBER, WOOD
HA-2	1'-0"	CONCRETE (FRESH CHIPS)
HA-3	2'-0"	IMPENETRABLE
HA-4	4"	CONCRETE
HA-5	2'-6"	PLASTIC & CONCRETE
HA-6	3'	---
HA-7	2'-0"	POSSIBLE CONCRETE
HA-8	3'-0"	LEAVES, ROPE
HA-9	3'-0"	PLASTIC
HA-10	1'-6"	PLASTIC
HA-11	2'-0"	WIRE, DEBRIS
HA-12	1'-9"	DEBRIS
HA-13	3'-0"	---

DWG\ESB8X11. 05/24/91 at 09:46

TABLE 6.1
SITE 2, FORMER LANDFILL C
DETECTED ANALYTES IN SOIL SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF2-SB1 (0'-1')*	VF2-SB2 (0'-1')*	VF2-SB3 (0'-1')*	VF2-SB4 (0'-1')*	VF2-SB5 (0'-1')*
Date Sampled	10/30/90	10/29/90	10/30/90	10/30/90	10/30/90
Halogenated Volatiles - SW8010 (ug/kg)	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/kg)					
Xylenes	U	U	U	9.1J2	U
Organochlorine Pesticides & PCB's - CLP SOW (ug/kg)					
4,4'-DDD	17J	U	U	U	U
4,4'-DDE	38	U	U	U	U
4,4'-DDT	28J	22J	U	U	U
Alpha Chlordane	84N	U	U	U	U
Semivolatile Organics - CLP SOW (ug/kg)					
Benzo(a)Anthracene	U	270J	U	U	U
Benzo(B)fluoranthene	260J	570	U	230J	U
Benzo(k)fluoranthene	260J	580	U	210J	U
Benzo(a)pyrene	230J	590	U	U	U
Benzo(g,h,i)perylene	U	410	U	UJ2	UJ2
Chrysene	240J	310J	U	U	U
Dibenzo(a,h)anthracene	U	180J	U	U	U
Indeno(1,2,3-cd)pyrene	U	350	U	U	U
Pyrene	390	420	U	210J	U
Fluoranthene	U	420	U	U	U
13 Priority Pollutant Metals (mg/kg)					
Chromium	4.2	2.3	1.4	2.5	1.2
Copper	3.9	3.7	U	3.6	1.2
Nickel	U	3.0	U	2.9	U
Zinc	23.3	12.6	2.1	7.5	4.6
Mercury	0.011J4	0.014	UJ4	UJ4	UJ4
Lead	22	11	U	3.5	U

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
N - Tentatively identified.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
* Incorrectly labeled as 1-2' on the chain-of-custody.

TABLE 6.2
SITE 2, FORMER LANDFILL C
DETECTED ANALYTES IN SEDIMENT SAMPLES, 1991
VOLK FIELD ANGB, WI

Parameters	VF2-SD1	VF2-SD2*	VF2-SD3	VF2-SD4
Date Sampled	07/10/91	07/10/91	07/10/91	07/10/91
Semivolatile Organics - CLP SOW(ug/kg)				
Benzoic Acid	U	2100J	U	U
Organochlorine Pesticides & PCB's - CLP SOW(ug/kg	ND	ND	ND	ND
13 Priority Pollutant Metals (mg/kg)				
Cadmium	5.4	2.4U	3.0	2.2U
Chromium	12	7.7	7.3	4.4
Copper	24	21	24	19
Zinc	1000	32	110	77
Arsenic	15.9	8.1	6.0	4.5UJ4
Mercury	0.24	0.16	0.24	0.23
Lead	72.5	13.7	58.7	19.8

ND - No analytes detected for this method.
U - Below the detection limit.
J, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
* - Upstream sediment sample

TABLE 6.3
SITE 2, FORMER LANDFILL C
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF2-MW1	VF2-MW2	VF2-MW3	VF2-MW4	VF2-MW5
Date Sampled	10/23/90	11/06/90	10/27/90	11/06/90	10/27/90
Halogenated Volatiles - SW8010 (ug/L)	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	ND	ND	ND	ND	ND
Organochlorine Pesticides & PCB's CLP SOW (ug/L)	ND	ND	ND	ND	ND
Semivolatile Organics - CLP SOW (ug/L)	ND	ND	ND	ND	ND
13 Priority Pollutant Metals (ug/L)	ND	ND	ND	ND	ND
Total Dissolved Solids - E160.1 (mg/L)	14	60	68	55	32

ND - No analytes detected for this method.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.

TABLE 6.4
SITE 2, FORMER LANDFILL C
DETECTED ANALYTES IN SURFACE WATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF2-SW1	VF2-SW2**	VF2-SW3	VF2-SW4	VF2-SW5***
Date Sampled	11/10/90	11/10/90	11/10/90	11/10/90	11/10/90
Halogenated Volatiles - SW8010 (ug/L)	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	ND	ND	ND	ND	ND
Organochlorine Pesticides & PCB's CLP SOW (ug/L)	ND	ND	ND	ND	ND
Semivolatile Organics - CLP SOW (ug/L)	ND	ND	ND	ND	ND
13 Priority Pollutant Metals (ug/L)*					
Zinc	10.7/U	38.8/41.2	U/U	U/99.4	13.0/U
Mercury	U/U	U/0.32	U/U	U/0.34	U/U
Lead	U/U	10.2J4/U	UJ/U	U/22.0J4	U/U
Total Dissolved Solids - E160.1 (mg/L)	130	180	330	520	340

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
* - Dissolved and Total Inorganics were analyzed on surface water samples (Dissolved/Total).
** - Upstream sample
*** - Duplicate of VF2-SW3.

TABLE 6.5
SITE 2, FORMER LANDFILL C
CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS (TOP 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Maximum Detected Concentration (a) (mg/kg)
Alpha Chlordane	0.084	1 / 4	5.10E-02	1.91E-02	8.40E-02
Benzo(a)anthracene	0.270	1 / 4	1.91E-01	4.55E-02	2.70E-01
Benzo(a)pyrene	0.230-0.590	2 / 4	2.88E-01	1.77E-01	5.90E-01
Benzo(b)fluoranthene	0.23-0.57	3 / 4	3.06E-01	1.56E-01	5.70E-01
Benzo(g,h,i)perylene	0.410	1 / 4	2.26E-01	1.06E-01	4.10E-01
Benzo(k)fluoranthene	0.210-0.580	3 / 4	3.04E-01	1.63E-01	5.80E-01
Chromium (VI)	1.4-4.2	4 / 4	2.60E+00	1.01E+00	4.20E+00
Chrysene	0.240-0.310	2 / 4	2.20E-01	6.03E-02	3.10E-01
Copper	3.6-3.9	3 / 4	2.93E+00	1.40E+00	3.90E+00
DDD	0.017	1 / 4	1.03E-02	3.90E-03	1.70E-02
DDE	0.038	1 / 4	1.55E-02	1.30E-02	3.80E-02
DDT	0.022-0.028	2 / 4	1.65E-02	8.76E-03	2.80E-02
Dibenzo(a,h)anthracene	0.180	1 / 4	1.69E-01	6.50E-03	1.80E-01
Fluoranthene	0.420	1 / 4	2.29E-01	1.10E-01	4.20E-01
Indeno(1,2,3-cd)pyrene	0.350	1 / 4	2.11E-01	8.01E-02	3.50E-01
Lead	3.5-22	3 / 4	9.19E+00	8.36E+00	2.20E+01
Pyrene	0.210-0.420	3 / 4	2.96E-01	1.10E-01	4.20E-01
Xylenes	0.0091	1 / 4	4.15E-03	2.86E-03	9.10E-03
Zinc	2.1-23.3	4 / 4	1.14E+01	7.82E+00	2.33E+01

(a) Sample size is less than 5 ($n < 5$), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 6.6
SITE 2, FORMER LANDFILL C
CHEMICALS OF CONCERN DETECTED IN SURFACE WATER
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency (a)	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (b) (mg/L)
Lead	0.022	1 / 9	9.94E-03	1.54E-02	2.18E-02
Mercury	0.00034	1 / 9	2.27E-04	2.83E-04	4.45E-04
Zinc	0.0107-.0994	4 / 9	1.87E-02	2.90E-02	4.09E-02

(a) Sample count includes both filtered and unfiltered data.
(b) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

TABLE 6.7
SITE 2, FORMER LANDFILL C
CHEMICALS OF CONCERN DETECTED IN SEDIMENTS
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (a) (mg/L)
Lead	19.8-72.5	3 / 3	5.03E+01	2.23E+01	7.25E+01
Zinc	77-1000	3 / 3	3.96E+02	4.28E+02	1.00E+03

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 6.8

SITE 2, FORMER LANDFILL C
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 2; areas downwind	Onsite workers, nearby residents	Inhalation	Unlikely. Xylene was the only VOC detected; Site is inactive and in a remote area.
	Contaminated soils/ fugitive dust generation	Site 2; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Low concentration of semi-volatiles and lead were detected in surface soils. The landfill is lightly vegetated and in a remote area.
Groundwater	Contaminated soils/leaching to groundwater	Downgradient wells	Onsite workers, nearby residents	Oral, dermal, inhalation	None. No groundwater contamination was detected.
Surface Water	Contaminated soils/ surface runoff	Little Lemonwier River	Onsite workers	Oral, dermal, inhalation	Low. Mercury, lead and zinc were detected in a surface water near this site.
Soils	Contaminated soils/ runoff, tracking	Site 2	Onsite workers, nearby residents	Oral, dermal	Very low. Low concentration of semi-volatiles and lead were detected in surface soils. The landfill is covered with soil, is lightly vegetated, and is in a remote area.
FUTURE USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 2; areas downwind	Future residents, onsite workers	Inhalation	Unlikely. A low concentration of xylene was detected in one surface soil sample, and no VOCs were detected in groundwater, deeper soils are unlikely to be contaminated with volatiles.
	Contaminated surface soils/fugitive dust generation	Site 2; areas downwind	Future residents, onsite workers	Inhalation	Very low. Low concentrations of semi-volatiles and lead have been detected in surface soils.

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TABLE 6.8–Continued

SITE 2, FORMER LANDFILL C
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
<u>FUTURE USE SCENARIOS</u> (Cont'd)					
Groundwater	Contaminated soils/leaching to groundwater	Wells onsite or downgradient.	Future residents, onsite workers	Oral, dermal, inhalation	None. No groundwater contamination was detected. Chemicals detected in surface soils are low in concentration and sorb tightly to soils.
Surface Water	Contaminated soil/ surface runoff	Little Lemonwier River	Future residents, onsite workers	Oral, dermal, inhalation	Low. Mercury, lead and zinc were detected in a surface water near this site.
Soils	Contaminated soils/leaching, runoff, tracking	Site 2	Future residents, onsite workers	Oral, dermal	Very low. Exposure is expected only if residences are developed or if site becomes active.

TABLE 6.9
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	1.10E-06	9.24E-08	1.30E+00	1.20E-07
Benzo(a)anthracene	2.70E-01	1.10E-06	2.97E-07	1.15E+01	3.42E-06
Benzo(a)pyrene	5.90E-01	1.10E-06	6.49E-07	1.15E+01	7.46E-06
Benzo(b)fluoranthene	5.70E-01	1.10E-06	6.27E-07	1.15E+01	7.21E-06
Benzo(k)fluoranthene	5.80E-01	1.10E-06	6.38E-07	1.15E+01	7.34E-06
Chrysene	3.10E-01	1.10E-06	3.41E-07	1.15E+01	3.92E-06
Copper	3.90E+00	1.10E-06	4.29E-06	NA	NA
DDD	1.70E-02	1.10E-06	1.87E-08	2.40E-01	4.49E-09
DDE	3.80E-02	1.10E-06	4.18E-08	3.40E-01	1.42E-08
DDT	2.80E-02	1.10E-06	3.08E-08	3.40E-01	1.05E-08
Dibenzo(a,h)anthracene	1.80E-01	1.10E-06	1.98E-07	1.15E+01	2.28E-06
Indeno(1,2,3-cd)pyrene	3.50E-01	1.10E-06	3.85E-07	1.15E+01	4.43E-06
Lead	2.20E+01	1.10E-06	2.42E-05	ND	NA
				CARCINOGENIC RISK =	4E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.10
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	1.28E-05	1.08E-06	6.00E-05	1.79E-02
Benzo(a)anthracene	2.70E-01	1.28E-05	3.46E-06	ND	NA
Benzo(a)pyrene	5.90E-01	1.28E-05	7.55E-06	ND	NA
Benzo(b)fluoranthene	5.70E-01	1.28E-05	7.30E-06	ND	NA
Benzo(g,h,i)perylene	4.10E-01	1.28E-05	5.25E-06	ND	NA
Benzo(k)fluoranthene	5.80E-01	1.28E-05	7.42E-06	ND	NA
Chromium (d)	4.20E+00	1.28E-05	5.38E-05	5.00E-03	1.08E-02
Chrysene	3.10E-01	1.28E-05	3.97E-06	ND	NA
Copper	3.90E+00	1.28E-05	4.99E-05	ND	NA
DDD	1.70E-02	1.28E-05	2.18E-07	ND	NA
DDE	3.80E-02	1.28E-05	4.86E-07	ND	NA
DDT	2.80E-02	1.28E-05	3.58E-07	5.00E-04	7.17E-04
Dibenzo(a,h)anthracene	1.80E-01	1.28E-05	2.30E-06	ND	NA
Fluoranthene	4.20E-01	1.28E-05	5.38E-06	4.00E-02	1.34E-04
Indeno(1,2,3-cd)pyrene	3.50E-01	1.28E-05	4.48E-06	ND	NA
Lead	2.20E+01	1.28E-05	2.82E-04	ND	NA
Pyrene	4.20E-01	1.28E-05	5.38E-06	3.00E-02	1.79E-04
Xylenes	9.10E-03	1.28E-05	1.16E-07	2.00E+00	5.82E-08
Zinc	2.33E+01	1.28E-05	2.98E-04	2.00E-01	1.49E-03
				HAZARD INDEX =	3E-02

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.11
SITE 2, FIRE TRAINING AREA
CARCINOGENIC RISK FOR INGESTION OF
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	3.49E-07	2.93E-08	1.30E+00	3.81E-08
Benzo(a)anthracene	2.70E-01	3.49E-07	9.42E-08	1.15E+01	1.08E-06
Benzo(a)pyrene	5.90E-01	3.49E-07	2.06E-07	1.15E+01	2.37E-06
Benzo(b)fluoranthene	5.70E-01	3.49E-07	1.99E-07	1.15E+01	2.29E-06
Benzo(k)fluoranthene	5.80E-01	3.49E-07	2.02E-07	1.15E+01	2.33E-06
Chrysene	3.10E-01	3.49E-07	1.08E-07	1.15E+01	1.24E-06
Copper	3.90E+00	3.49E-07	1.36E-06	NA	NA
DDD	1.70E-02	3.49E-07	5.93E-09	2.40E-01	1.42E-09
DDE	3.80E-02	3.49E-07	1.33E-08	3.40E-01	4.51E-09
DDT	2.80E-02	3.49E-07	9.77E-09	3.40E-01	3.32E-09
Dibenzo(a,h)anthracene	1.80E-01	3.49E-07	6.28E-08	1.15E+01	7.22E-07
Indeno(1,2,3-cd)pyrene	3.50E-01	3.49E-07	1.22E-07	1.15E+01	1.40E-06
Lead	2.20E+01	3.49E-07	7.68E-06	ND	NA
			CARCINOGENIC RISK =		1E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.12
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	9.78E-07	8.22E-08	6.00E-05	1.37E-03
Benzo(a)anthracene	2.70E-01	9.78E-07	2.64E-07	ND	NA
Benzo(a)pyrene	5.90E-01	9.78E-07	5.77E-07	ND	NA
Benzo(b)fluoranthene	5.70E-01	9.78E-07	5.57E-07	ND	NA
Benzo(g,h,i)perylene	4.10E-01	9.78E-07	4.01E-07	ND	NA
Benzo(k)fluoranthene	5.80E-01	9.78E-07	5.67E-07	ND	NA
Chromium (d)	4.20E+00	9.78E-07	4.11E-06	5.00E-03	8.22E-04
Chrysene	3.10E-01	9.78E-07	3.03E-07	ND	NA
Copper	3.90E+00	9.78E-07	3.81E-06	ND	NA
DDD	1.70E-02	9.78E-07	1.66E-08	ND	NA
DDE	3.80E-02	9.78E-07	3.72E-08	ND	NA
DDT	2.80E-02	9.78E-07	2.74E-08	5.00E-04	5.48E-05
Dibenzo(a,h)anthracene	1.80E-01	9.78E-07	1.76E-07	ND	NA
Fluoranthene	4.20E-01	9.78E-07	4.11E-07	4.00E-02	1.03E-05
Indeno(1,2,3-cd)pyrene	3.50E-01	9.78E-07	3.42E-07	ND	NA
Lead	2.20E+01	9.78E-07	2.15E-05	ND	NA
Pyrene	4.20E-01	9.78E-07	4.11E-07	3.00E-02	1.37E-05
Xylenes	9.10E-03	9.78E-07	8.90E-09	2.00E+00	4.45E-09
Zinc	2.33E+01	9.78E-07	2.28E-05	2.00E-01	1.14E-04
				HAZARD INDEX =	2E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.13
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	5.87E-07	4.93E-08	1.30E+00	6.41E-08
Benzo(a)anthracene	2.70E-01	5.87E-07	1.58E-07	1.15E+01	1.82E-06
Benzo(a)pyrene	5.90E-01	5.87E-07	3.46E-07	1.15E+01	3.98E-06
Benzo(b)fluoranthene	5.70E-01	5.87E-07	3.35E-07	1.15E+01	3.85E-06
Benzo(k)fluoranthene	5.80E-01	5.87E-07	3.40E-07	1.15E+01	3.92E-06
Chrysene	3.10E-01	5.87E-07	1.82E-07	1.15E+01	2.09E-06
Copper	3.90E+00	5.87E-07	2.29E-06	NA	NA
DDD	1.70E-02	5.87E-07	9.98E-09	2.40E-01	2.39E-09
DDE	3.80E-02	5.87E-07	2.23E-08	3.40E-01	7.58E-09
DDT	2.80E-02	5.87E-07	1.64E-08	3.40E-01	5.59E-09
Dibenzo(a,h)anthracene	1.80E-01	5.87E-07	1.06E-07	1.15E+01	1.22E-06
Indeno(1,2,3-cd)pyrene	3.50E-01	5.87E-07	2.05E-07	1.15E+01	2.36E-06
Lead	2.20E+01	5.87E-07	1.29E-05	ND	NA
				CARCINOGENIC RISK =	2E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.14
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	1.37E-06	1.15E-07	6.00E-05	1.92E-03
Benzo(a)anthracene	2.70E-01	1.37E-06	3.70E-07	ND	NA
Benzo(a)pyrene	5.90E-01	1.37E-06	8.08E-07	ND	NA
Benzo(b)fluoranthene	5.70E-01	1.37E-06	7.81E-07	ND	NA
Benzo(g,h,i)perylene	4.10E-01	1.37E-06	5.62E-07	ND	NA
Benzo(k)fluoranthene	5.80E-01	1.37E-06	7.95E-07	ND	NA
Chromium (d)	4.20E+00	1.37E-06	5.75E-06	5.00E-03	1.15E-03
Chrysene	3.10E-01	1.37E-06	4.25E-07	ND	NA
Copper	3.90E+00	1.37E-06	5.34E-06	ND	NA
DDD	1.70E-02	1.37E-06	2.33E-08	ND	NA
DDE	3.80E-02	1.37E-06	5.21E-08	ND	NA
DDT	2.80E-02	1.37E-06	3.84E-08	5.00E-04	7.67E-05
Dibenzo(a,h)anthracene	1.80E-01	1.37E-06	2.47E-07	ND	NA
Fluoranthene	4.20E-01	1.37E-06	5.75E-07	4.00E-02	1.44E-05
Indeno(1,2,3-cd)pyrene	3.50E-01	1.37E-06	4.80E-07	ND	NA
Lead	2.20E+01	1.37E-06	3.01E-05	ND	NA
Pyrene	4.20E-01	1.37E-06	5.75E-07	3.00E-02	1.92E-05
Xylenes	9.10E-03	1.37E-06	1.25E-08	2.00E+00	6.23E-09
Zinc	2.33E+01	1.37E-06	3.19E-05	2.00E-01	1.60E-04
				HAZARD INDEX =	3E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.15
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concnetration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	1.60E-06	1.34E-07	1.30E+00	1.75E-07
Benzo(a)anthracene	2.70E-01	3.20E-07	8.64E-08	1.15E+01	9.94E-07
Benzo(a)pyrene	5.90E-01	3.20E-07	1.89E-07	1.15E+01	2.17E-06
Benzo(b)fluoranthene	5.70E-01	3.20E-07	1.82E-07	1.15E+01	2.10E-06
Benzo(k)fluoranthene	5.80E-01	3.20E-07	1.86E-07	1.15E+01	2.13E-06
Chromium (VI)	4.20E+00	NA (d)	NA	ND	NA
Chrysene	3.10E-01	3.20E-07	9.92E-08	1.15E+01	1.14E-06
Copper	3.90E+00	NA (d)	NA	NA	NA
DDD	1.70E-02	1.60E-06	2.72E-08	2.40E-01	6.53E-09
DDE	3.80E-02	1.60E-06	6.08E-08	3.40E-01	2.07E-08
DDT	2.80E-02	1.60E-06	4.48E-08	3.40E-01	1.52E-08
Dibenzo(a,h)anthracene	1.80E-01	3.20E-07	5.76E-08	1.15E+01	6.62E-07
Indeno(1,2,3-cd)pyrene	3.50E-01	3.20E-07	1.12E-07	1.15E+01	1.29E-06
Lead	2.20E+01	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		1E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 6.16
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	1.86E-05	1.56E-06	6.00E-05	2.60E-02
Benzo(a)anthracene	2.70E-01	3.73E-06	1.01E-06	ND	NA
Benzo(a)pyrene	5.90E-01	3.73E-06	2.20E-06	ND	NA
Benzo(b)fluoranthene	5.70E-01	3.73E-06	2.13E-06	ND	NA
Benzo(g,h,i)perylene	4.10E-01	3.73E-06	1.53E-06	ND	NA
Benzo(k)fluoranthene	5.80E-01	3.73E-06	2.16E-06	ND	NA
Chromium (f)	4.20E+00	NA (e)	NA	5.00E-03	NA
Chrysene	3.10E-01	3.73E-06	1.16E-06	ND	NA
Copper	3.90E+00	NA (e)	NA	ND	NA
DDD	1.70E-02	1.86E-05	3.16E-07	ND	NA
DDE	3.80E-02	1.86E-05	7.07E-07	ND	NA
DDT	2.80E-02	1.86E-05	5.21E-07	5.00E-04	1.04E-03
Dibenzo(a,h)anthracene	1.80E-01	3.73E-06	6.71E-07	ND	NA
Fluoranthene	4.20E-01	3.73E-06	1.57E-06	4.00E-02	3.92E-05
Indeno(1,2,3-cd)pyrene	3.50E-01	3.73E-06	1.31E-06	ND	NA
Lead	2.20E+01	NA (e)	NA	ND	NA
Pyrene	4.20E-01	3.73E-06	1.57E-06	3.00E-02	5.22E-05
Xylenes	9.10E-03	1.86E-05	1.69E-07	2.00E+00	8.46E-08
Zinc	2.33E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	3E-02

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.17
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	2.37E-06	1.99E-07	1.30E+00	2.59E-07
Benzo(a)anthracene	2.70E-01	4.74E-07	1.28E-07	1.15E+01	1.47E-06
Benzo(a)pyrene	5.90E-01	4.74E-07	2.80E-07	1.15E+01	3.22E-06
Benzo(b)fluoranthene	5.70E-01	4.74E-07	2.70E-07	1.15E+01	3.11E-06
Benzo(k)fluoranthene	5.80E-01	4.74E-07	2.75E-07	1.15E+01	3.16E-06
Chromium (VI)	4.20E+00	NA (d)	NA	ND	NA
Chrysene	3.10E-01	4.74E-07	1.47E-07	1.15E+01	1.69E-06
Copper	3.90E+00	NA (d)	NA	NA	NA
DDD	1.70E-02	2.37E-06	4.03E-08	2.40E-01	9.67E-09
DDE	3.80E-02	2.37E-06	9.01E-08	3.40E-01	3.06E-08
DDT	2.80E-02	2.37E-06	6.64E-08	3.40E-01	2.26E-08
Dibenzo(a,h)anthracene	1.80E-01	4.74E-07	8.53E-08	1.15E+01	9.81E-07
Indeno(1,2,3-cd)pyrene	3.50E-01	4.74E-07	1.66E-07	1.15E+01	1.91E-06
Lead	2.20E+01	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		2E-05

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 6.18
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	6.64E-06	5.58E-07	6.00E-05	9.30E-03
Benzo(a)anthracene	2.70E-01	1.33E-06	3.59E-07	ND	NA
Benzo(a)pyrene	5.90E-01	1.33E-06	7.85E-07	ND	NA
Benzo(b)fluoranthene	5.70E-01	1.33E-06	7.58E-07	ND	NA
Benzo(g,h,i)perylene	4.10E-01	1.33E-06	5.45E-07	ND	NA
Benzo(k)fluoranthene	5.80E-01	1.33E-06	7.71E-07	ND	NA
Chromium (f)	4.20E+00	NA (e)	NA	5.00E-03	NA
Chrysene	3.10E-01	1.33E-06	4.12E-07	ND	NA
Copper	3.90E+00	NA (e)	NA	ND	NA
DDD	1.70E-02	6.64E-06	1.13E-07	ND	NA
DDE	3.80E-02	6.64E-06	2.52E-07	ND	NA
DDT	2.80E-02	6.64E-06	1.86E-07	5.00E-04	3.72E-04
Dibenzo(a,h)anthracene	1.80E-01	1.33E-06	2.39E-07	ND	NA
Fluoranthene	4.20E-01	1.33E-06	5.59E-07	4.00E-02	1.40E-05
Indeno(1,2,3-cd)pyrene	3.50E-01	1.33E-06	4.66E-07	ND	NA
Lead	2.20E+01	NA (e)	NA	ND	NA
Pyrene	4.20E-01	1.33E-06	5.59E-07	3.00E-02	1.86E-05
Xylenes	9.10E-03	6.64E-06	6.04E-08	2.00E+00	3.02E-08
Zinc	2.33E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-02

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.19
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concnetration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Alpha Chlordane	8.40E-02	9.43E-07	7.92E-08	1.30E+00	1.03E-07
Benzo(a)anthracene	2.70E-01	1.89E-07	5.10E-08	1.15E+01	5.87E-07
Benzo(a)pyrene	5.90E-01	1.89E-07	1.12E-07	1.15E+01	1.28E-06
Benzo(b)fluoranthene	5.70E-01	1.89E-07	1.08E-07	1.15E+01	1.24E-06
Benzo(k)fluoranthene	5.80E-01	1.89E-07	1.10E-07	1.15E+01	1.26E-06
Chromium (VI)	4.20E+00	NA (d)	NA	ND	NA
Chrysene	3.10E-01	1.89E-07	5.86E-08	1.15E+01	6.74E-07
Copper	3.90E+00	NA (d)	NA	NA	NA
DDD	1.70E-02	9.43E-07	1.60E-08	2.40E-01	3.85E-09
DDE	3.80E-02	9.43E-07	3.58E-08	3.40E-01	1.22E-08
DDT	2.80E-02	9.43E-07	2.64E-08	3.40E-01	8.98E-09
Dibenzo(a,h)anthracene	1.80E-01	1.89E-07	3.40E-08	1.15E+01	3.91E-07
Indeno(1,2,3-cd)pyrene	3.50E-01	1.89E-07	6.62E-08	1.15E+01	7.61E-07
Lead	2.20E+01	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		6E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 6.20
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Alpha Chlordane	8.40E-02	2.20E-06	1.85E-07	6.00E-05	3.08E-03
Benzo(a)anthracene	2.70E-01	4.40E-07	1.19E-07	ND	NA
Benzo(a)pyrene	5.90E-01	4.40E-07	2.60E-07	ND	NA
Benzo(b)fluoranthene	5.70E-01	4.40E-07	2.51E-07	ND	NA
Benzo(g,h,i)perylene	4.10E-01	4.40E-07	1.80E-07	ND	NA
Benzo(k)fluoranthene	5.80E-01	4.40E-07	2.55E-07	ND	NA
Chromium (f)	4.20E+00	NA (e)	NA	5.00E-03	NA
Chrysene	3.10E-01	4.40E-07	1.36E-07	ND	NA
Copper	3.90E+00	NA (e)	NA	ND	NA
DDD	1.70E-02	2.20E-06	3.74E-08	ND	NA
DDE	3.80E-02	2.20E-06	8.36E-08	ND	NA
DDT	2.80E-02	2.20E-06	6.16E-08	5.00E-04	1.23E-04
Dibenzo(a,h)anthracene	1.80E-01	4.40E-07	7.92E-08	ND	NA
Fluoranthene	4.20E-01	4.40E-07	1.85E-07	4.00E-02	4.62E-06
Indeno(1,2,3-cd)pyrene	3.50E-01	4.40E-07	1.54E-07	ND	NA
Lead	2.20E+01	NA (e)	NA	ND	NA
Pyrene	4.20E-01	4.40E-07	1.85E-07	3.00E-02	6.16E-06
Xylenes	9.10E-03	2.20E-06	2.00E-08	2.00E+00	1.00E-08
Zinc	2.33E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	3E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 6.21
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF SURFACE WATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	2.18E-02	2.19E-03	4.77E-05	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Because only metals were found in surface water and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in surface water represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.22
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
SURFACE WATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	2.18E-02	1.88E-04	4.10E-06	ND	NA
Mercury	4.45E-04	1.88E-04	8.37E-08	3.00E-04	2.79E-04
Zinc	4.09E-02	1.88E-04	7.69E-06	2.00E-01	3.84E-05
				HAZARD INDEX =	3E-04

(a) Because only metals were found in surface water and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in surface water represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.23
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF SURFACE WATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	2.18E-02	2.01E-04	4.38E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Because only metals were found in surface water and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in surface water represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.24
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE WATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	2.18E-02	4.70E-04	1.02E-05	ND	NA
Mercury	4.45E-04	4.70E-04	2.09E-07	3.00E-04	6.97E-04
Zinc	4.09E-02	4.70E-04	1.92E-05	2.00E-01	9.61E-05
				HAZARD INDEX =	8E-04

(a) Because only metals were found in surface water and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in surface water represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.25
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF
SEDIMENTS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Sediments (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.25E+01	7.83E-07	5.68E-05	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Because only metals were found in sediments and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in sediments represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 6.26
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SEDIMENTS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Sediments (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	7.25E+01	9.13E-06	6.62E-04	ND	NA
Zinc	1.00E+03	9.13E-06	9.13E-03	2.00E-01	4.57E-02
				HAZARD INDEX =	5E-02

(a) Because only metals were found in sediments and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in sediments represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.27
SITE 2, FORMER LANDFILL C
CARCINOGENIC RISK FOR INGESTION OF
SEDIMENTS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Sediments (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.25E+01	3.26E-08	2.36E-06	ND	NA
					0E+00

(a) Because only metals were found in sediments and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in sediments represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.28
SITE 2, FORMER LANDFILL C
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SEDIMENTS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Sediments (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	7.25E+01	9.78E-07	7.09E-05	ND	NA
Zinc	1.00E+03	9.78E-07	9.78E-04	2.00E-01	4.89E-03
				HAZARD INDEX =	5E-03

(a) Because only metals were found in sediments and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(b) Concentration in sediments represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 6.29
SITE 2, FORMER LANDFILL C
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Fxposure Pathway	Pathway Risk	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	1E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
	Dermal Absorption from Surface Soils	2E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
Future Onsite Workers	Incidental Ingestion of Surface Soils	1E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
	Dermal Absorption from Surface Soils	2E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
Future Adult Residents	Incidental Ingestion of Surface Soils	2E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
	Incidental Ingestion of Surface Water	NQ (a)	—
	Incidental Ingestion of Sediments	NQ (a)	—
	Dermal Absorption from Surface Soils	6E-06	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
Future Children	Incidental Ingestion of Surface Soils	4E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene
	Incidental Ingestion of Surface Water	NQ (a)	—
	Incidental Ingestion of Sediments	NQ (a)	—
	Dermal Absorption from Surface Soils	1E-05	Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene

(a) Not Quantifiable; there is no carcinogenic slope factor for lead.

TABLE 6.30
SITE 2, FORMER LANDFILL C
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	2E-03	Alpha Chlordane, [illegible]mium
	Dermal Absorption from Surface Soils	1E-02	Alpha Chlordane
Future Onsite Workers	Incidental Ingestion of Surface Soils	2E-03	Alpha Chlordane, Chromium
	Dermal Absorption from Surface Soils	1E-02	Alpha Chlordane
Future Adult Residents	Incidental Ingestion of Surface Soils	3E-03	Alpha Calordane, Chromium
	Incidental Ingestion of Sediments	5E-03	Zinc
	Incidental Ingestion of Surface Water	8E-04	Mercury
	Dermal Absorption from Surface Soils	3E-03	Alpha Chlordane
Future Children	Incidental Ingestion of Surface Soils	3E-02	Alpha Chlordane, Chromium
	Incidental Ingestion of Sediments	5E-02	Zinc
	Incidental Ingestion of Surface Water	3E-04	Mercury
	Dermal Absorption from Surface Soils	3E-02	Alpha Chlordane

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TABLE 6.31
CHEMICAL CONSTITUENTS DETECTED AT SITE 2
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Alpha Chlordane	1990	0.084	--	--	--
Benzo(a)anthracene	1990	0.27	--	--	--
Benzo(b)fluoranthene	1990	0.57	--	--	--
Benzo(k)fluoranthene	1990	0.58	--	--	--
Benzo(g,h,i)perylene	1990	0.41	--	--	--
Benzo(a)pyrene	1990	0.59	--	--	--
Chromium (VI)	1990	4.2	--	--	--
Chrysene	1990	0.31	--	--	--
Copper	1990	3.9	--	--	--
4,4-DDD	1990	0.017	--	--	--
4,4-DDE	1990	0.038	--	--	--
4,4-DDT	1990	0.028	--	--	--
Dibenzo(a,h)anthracene	1990	0.18	--	--	--
Fluoranthene	1990	0.42	--	--	--
Indeno(1,2,3-cd)pyrene	1990	0.35	--	--	--
Lead	1990	22	--	--	--
Mercury	1990	0.014	--	--	--
Nickel	1990	3.0	--	--	--
Pyrene	1990	0.42	--	--	--
Xylenes	1990	0.0091	--	--	--
Zinc	1990	23.3	--	--	--

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TABLE 6.31--Continued
CHEMICAL CONSTITUENTS DETECTED AT SITE 2
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Groundwater (ug/L)					
Arsenic	1988	5(1)	MCL/WIDNR	50	No
Beryllium	1988	1(1)	--	--	--
Bis(2-ethylhexyl)phthalate	1988	11 (2)	--	--	--
Chromium (VI)	1988	30(1)	WIDNR	50	No
Copper	1988	30(1)	WIDNR	1,000	No
Lead	1988	10(1, 2)	MCL	15	No
Nickel	1988	20(1)	--	--	--
Silver	1988	10(1)	WIDNR	50	No
TDS	1988, 1990	73,000	--	--	--
Zinc	1988	50(1)	WIDNR	5,000	No
Sediments (mg/kg)					
Arsenic	1991	15.9	--	--	--
Benzoic Acid	1991	2.1(2)	--	--	--
Cadmium	1991	5.4	--	--	--
Chromium (VI)	1991	12.0	--	--	--
Copper	1991	24.0	--	--	--
Lead	1991	72.5	--	--	--
Mercury	1991	0.24	--	--	--
Zinc	1991	1000	--	--	--

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TABLE 6.31--Continued
CHEMICAL CONSTITUENTS DETECTED AT SITE 2
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Surface Water (ug/L)					
Copper	1988	10(1, 2)	FAWQC	30	No
Lead	1988, 1990	22	FAWQC	3.2	Yes
Mercury	1990	0.34	FAWQC	0.012	Yes
TDS	1988, 1990	520,000	--	--	--
Thallium	1988	120(1, 2)	FAWQC (HH)	7.2	Yes
Zinc	1988, 1990	99.4	WIDNRSW	62.69	Yes

MCL - Safe Drinking Water Act Maximum Contaminant Level.

WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.

WIDNRSW - Wisconsin Department of Natural Resources Surface Water Criteria.

FAWQC (HH) - Federal Ambient Water Quality Criterion for Human Health, consumption of organisms.

(1) - Unfiltered sample.

(2) - Detected in background sample or upgradient well.

SECTION 7
SITE 3/6 - FUEL SPILL SITE

BACKGROUND

Descriptions of Site 3 and Site 6 are provided in this subsection including a summary of activities relating to construction and tank removals. The activities associated with the three field investigations under the IRP are also summarized.

Site Description

Site 3 is located along the railroad tracks adjacent to the Petroleum Oils and Lubricants (POL) Storage Area (Figure 7.1). Routine spills of JP-4 and AVGAS have reportedly occurred at this site over the past 30 years. The total estimated fuel spilled at this site is approximately 3,000 gallons, based on an estimated rate of 50 spills per year and two gallons per spill. Visible evidence of surface contamination in the vicinity of the railcar staging area was identified during the IRP Phase I [HMTC, 1984]. An area of fuel staining has been observed north of the fuel pump house (Building 32). This staining is the result of fuel leaking from fuel trucks parked in this area. Adjacent to this area various containers such as drums and small cans were stored. Further north is another area of stressed vegetation.

At least six underground storage tanks were in use at various times during operation of the POL area. These tanks were located in the area of Site 3 adjacent to the railroad tracks near Buildings 30, 32 and 33. Some of these tanks have been removed.

Site 6 is the POL Storage Area located to the northeast of Site 3 as indicated on Figure 7.1. Two aboveground storage tanks with capacities of 200,000 gallons each are present at Site 6. Approximately 3,500 gallons of JP-4 was lost from the northernmost tank in 1980. The release was originally confined to the dike area surrounding the tank. This earthen dike was breached and the JP-4 was routed into a pit adjacent to the dike area. Approximately 1,000 gallons were recovered and the remaining fuel either evaporated or seeped into the ground [HMTC, 1984]. Base personnel identified an area northeast of the tanks where JP-4 had flowed during the cleanup efforts. Following the cleanup effort, the containment structure was paved with concrete [HMTC, 1984].

Site History

During the summer of 1988 one UST was removed from the area (labeled "A" on Figure 7.1) southwest of Building 32. During excavation of the tank, some visible evidence of contamination was noted. This tank was one of four tanks located adjacent to each other. These tanks each had a capacity of approximately 10,000 gallons. Base personnel stated these tanks contained heating oil.

In 1988, the Base began upgrading the POL facility. This effort involved replacing cracked concrete in the roadways. Surface water runoff was directed to a surface impoundment located north of the two aboveground tanks following this construction.

As part of the facility upgrade, four additional USTs were removed from Site 3. The four USTs included the three remaining tanks near Building 32 and a fourth larger tank located adjacent to the railroad tracks south of a storage shed (Building 30). The fourth tank was located in the area labeled "C" on Figure 7.1. Base personnel reported the tank removal program included the removal and disposal of approximately 7,690 cubic yards of contaminated soil at an asphalt facility located in Tomah, Wisconsin [Belcher, 1991]. The excavation was backfilled with clean soils. Contaminated soils were also removed from the area north of the fuel pump house where fuel staining was present.

During installation of utilities at Site 3, underground piping of an unknown function was encountered. A subsequent review of historic blue prints indicated two additional USTs are located beneath the storage shed. The existence of these tanks as indicated on the blue prints was not confirmed. The approximate location indicated by the blue prints is labeled "B" on Figure 7.1.

Numerous underground product lines are present which interconnect Sites 3 and 6 (Site 3/6). The exact layout and condition of these lines is unknown. A single UST is also located south of Building 33 in the area labeled D on Figure 7.1.

1987 Field Activities

In 1987, an SI was conducted at Site 3/6. Activities included a soil gas survey and the installation of one monitoring well. Two soil samples were collected from the monitoring well boring. Aromatic volatile organics were detected in the 3.5 feet soil sample at low concentrations. Aromatic volatile organics were also detected in the groundwater sample collected at MW-1. Analytical summary tables for this investigation are presented in Appendix G. The benzene concentration of 1.6 $\mu g/L$ exceeded the Wisconsin Preventive Action Limit [ES, 1990c].

1989 Field Activities

The 1989 field program included the installation of monitoring wells and soil and groundwater sampling.

Five monitoring wells were installed by the rotary wash method. The location of these well are depicted on Figure 7.1. An upgradient well (MW-4) was located west of the railroad tracks while three wells (MW-2, MW-3 and MW-5) were installed downgradient of the probable sources of contamination. These four wells were screened from 6 to 21 feet. A fifth well, MW-6, was installed to form a cluster pair with MW-3 and screened from 50 to 60 feet.

Groundwater samples were collected from each of the newly installed wells and analyzed for aromatic volatile organics, TPH, TDS and field parameters (specific conductance, pH and temperature). Groundwater levels were measured at all wells on 13 December 1989. After completion of the sampling, the five wells were surveyed for location and elevation.

1990 Field Activities

The 1990 field activities included soil boring, exploratory hand augering, monitoring well installation and soil and groundwater sampling.

Extensive exploratory hand augering was performed at Site 3/6 to determine the placement of monitoring wells and soil borings. The locations of these exploratory hand augerings are shown on Figure 7.2. Sixteen soil borings were completed and twenty soil samples were collected. The soil borings were advanced with a hand auger and were typically terminated at depths of 5 to 8 feet. The samples were analyzed for aromatic volatile organics, TPH and lead.

Two temporary monitoring wells were installed in hand augered borings to help define the horizontal extent of groundwater contamination. One temporary well, TW-1, was located in the northwest corner of the property, approximately 100 feet from the northern fence line. A second temporary well, TW-2, was installed about 5 feet north of Building 33. Both temporary wells were screened across the water table, from about 4 to 9 feet BLS.

Two permanent wells, MW-7 and MW-8, were installed to further characterize the horizontal extent of contamination. These wells were installed by rotary wash and were screened from 8 to 23 feet. The monitoring well locations are indicated on Figure 7.3.

Groundwater samples were obtained from all of the permanent wells at this site and from TW-1. All groundwater samples were analyzed for the same parameters as in 1987/1988 and 1989.

Groundwater measurements were taken at the beginning of the 1990 field investigation and again after ES field activities were completed. Surveying activities at this site included determining the location and elevation of the 16 soil borings, all 1990 monitoring wells and the resurveying of the cluster well pair (MW-3 and MW-6).

1991 Field Activities

The 1991 field event consisted of exploratory hand augering and groundwater elevation measurements. The hand augering was completed to isolate the source of contamination at monitoring well MW-1 detected during the 1990 field investigations. A total of seven borings were hand augered to depths of up to 9 feet. The location of these borings are shown on Figure 7.2.

Groundwater elevations were measured at all monitoring wells on 30 October 1991.

RESULTS

The results of the 1989, 1990 and 1991 field investigations are provided in this subsection. Hand auger logs, monitoring well logs and a summary of all water level data are included in Appendix B. The well construction details and water elevations for 13 November 1990 are presented in Table 2.4 of the Environmental Setting. Figure 7.3 depicts a potentiometric map showing the generalized direction of groundwater flow for Site 3/6 based on these elevations.

Geology/Hydrogeology

Site 3/6 is underlain by predominantly fine to medium grained yellowish-brown sand of Pleistocene age which contains occasional lenses of brown clay. Underneath the sand, Cambrian sandstone is encountered at depths ranging from approximately 8 to 18 feet. The location of a hydrogeologic cross-section for the site is shown on Figure 7.4. The cross-section (B-B′) is presented on Figure 7.5.

Groundwater elevations measured on 13 November 1990 indicate groundwater flow is toward the northeast with an average horizontal gradient of 0.003 ft/ft (Figure 7.3). A slight downward vertical gradient of 0.0013 ft/ft was measured between the surficial sands and the sandstone in wells MW-3 and MW-6. Hydraulic conductivity was estimated from a previous slug test at 36.5 gpd/ft^2 or 4.8 ft/day (1.7 $\times 10^{-3}$ cm/sec) [ES, 1990c]. This was used to determine the groundwater flow velocity for the site which is estimated to be 0.07 ft/day or 26.7 ft/yr. This value was calculated using the hydraulic conductivity (estimated from slug tests), the hydraulic gradient and a porosity of 0.2 [Bouwer, 1978].

Soil Sampling Results

Exploratory borings and screening of headspace for volatile organics were used to investigate areas of suspected soil contamination. The results of the headspace screening are given on Figure 7.6; additional data are presented in Appendix B. Soil sampling for analysis was used to confirm the results obtained during the screening. Analytical results of the soil sampling are shown on Figure 7.7. A summary of the analyses is given in Table 7.1.

The following provides a discussion of the results of the soil sampling effort. For the purpose of discussing the soil sampling results this subsection was organized by three areas: Site 3, Site 6 and the northern portion of Site 3/6. A comprehensive discussion of the lead results from all three areas (Site 3/6) is presented in the beginning of the following subsection.

Site 3/6 Lead Results

All soil samples were analyzed for lead. Lead was found in all samples at levels ranging from 0.54 mg/kg to 14 mg/kg. These concentrations were compared to background levels of lead determined at three different locations at the Base (Table 4.5). The background locations and levels encountered include: Site 1 - 1.2 to 1.6 mg/kg, Site 2 - below detection levels and Site 9 - 3.9 mg/kg. Thus, the maximum concentration of lead in background samples was 3.9 mg/kg. Discussions of the background results are found in Sections 5 (Site 1), 6 (Site 2) and 12 (Site 9) of this report.

At Site 3/6 lead levels were above the maximum background concentration of 3.9 mg/kg in samples obtained from soil borings SB-2, SB-3, SB-5, SB-6, SB-9 and SB-15. The highest concentration of lead was found at SB-3 at 14 mg/kg; however, no other contaminants were detected at SB-3. The low levels of lead detected at Site 3/6 and the fact that the highest lead concentration was found in an area where fuel contamination was not confirmed indicate the lead may not be a result of past leaded fuel handling activities at this site. The potential risk due to lead is discussed in the baseline risk assessment presented later in this section.

Site 3

The fuel handling area (Site 3) is located between the railroad tracks and the aboveground storage tanks. A total of twenty-four exploratory borings were advanced in this area and headspace samples were screened for volatile organics. Twenty-one of these borings were completed in 1990 and three in 1991. The shaded area on Figure 7.6 shows the approximate area of soil contamination based on headspace screening results. The shaded area encompasses approximately 1540 square yards. Assuming the soil is contaminated to an average depth of 10 feet (approximate depth to groundwater), the total volume of contaminated soil may be 5100 cubic yards. It is noted that clean up criteria have not been established and remediation of the entire shaded area may not be required.

Headspace readings exceeded 1,000 parts per million (ppm) at six locations within this shaded area. These higher readings are confined to two areas. One area is located in the vicinity of Building 30. According to historic blue prints of this site, two USTs may be located here. The other area of high headspace readings is located to the south of the fuel storage area surrounding Building 33. A single UST is located just south of this building.

An exploratory boring in the median of the paved roadway (northeast of Building 30) was advanced to 8.5 feet BLS. Headspace screening on a sample obtained from the bottom of this boring indicated the presence of volatile organics (740 ppm). This sample was obtained very close to or below the water table.

Eleven soil samples were taken in the fuels handling area at depths ranging from 0 to 8 feet BLS (Figure 7.7). Borings SB-4 and SB-7 are located in the northern part of the fuels handling area where a total of four USTs and contaminated soils were removed. Volatile organics and TPH were not detected in samples from these borings. Headspace screening near SB-4 indicated organics were present (120 ppm) in the sample obtained at the water table.

The sample from SB-5 contained ethylbenzene at 8.9 mg/kg and TPH at 5,600 mg/kg. The sample from boring SB-16 contained toluene at 73 mg/kg, xylene at 110 mg/kg and TPH at 3,400 mg/kg. These two samples were the only samples that contained volatile organics.

The remaining samples contained TPH at concentrations less than 63 mg/kg.

Site 6

Headspace screening and confirmatory soil sampling was used to investigate the area where a spill from the aboveground storage tank occurred (Site 6 on Figure 7.6). The presence of volatile organics in soils was confirmed in this area during the 1987 investigation. Further work was needed to determine the extent of soil contamination. In November 1990, four exploratory borings were advanced in this area and headspace samples from various depths were screened for the presence of organics. No organics were detected. Boring SB-3 (Figure 7.7) was advanced in close proximity to these four borings and in an area where the 1987 soil gas survey detected volatile organics. Two samples were collected for analysis from boring SB-3. The samples did not contain volatile organics or TPH.

An increase in groundwater contamination at MW-1 at Site 6 from previous 1987/1988 results was identified in 1990. In October 1991, four exploratory borings were completed along the northeast side of the aboveground storage tanks to identify the source of groundwater contamination. Elevated headspace readings were obtained at the two hand auger locations shown on Figure 7.6. An increase in organic vapor readings was observed with boring depth. Readings at one boring ranged from 6 ppm at 3 feet to 300 ppm at 9 feet and 140 ppm at 3 feet to 700 ppm at 9 feet at the other boring. These results are provided in detail in Appendix B.

The higher readings at 9 feet may indicate the presence of groundwater contamination at these boring locations. Both of these boring are downgradient of the aboveground storage tanks at Site 6. Three auger holes on the upgradient side of the tanks did not shown elevated headspace readings. This suggests a possible source of groundwater contamination may be located under the concrete dike. Confirmatory sampling was not conducted at these exploratory borings.

Northern Area

In 1990, twelve exploratory borings were advanced in the northern part of Site 3/6 (Figure 7.6). Various containers such as drums and small cans are stored and fuel trucks are parked in the grassy area north of the paved roadway. Surface staining is visible in this general area. Further north, towards the fence which encloses Site 3/6, the vegetation is also stressed. The origin of the contaminants which caused the stressed vegetation is unknown.

Exploratory borings were advanced in the areas where stressed vegetation was evident. Headspace screening from soil samples obtained at various depths in each boring were used to determine where soil sampling was required. The shaded area on Figure 7.6 depicts the approximate areal extent of contamination based on elevated headspace readings. The shaded areas encompass approximately 1560 square yards. Assuming the soil is contaminated to an average depth of 10 feet (approximate depth to groundwater), the total volume of contaminated soil may be 5200 cubic yards. It is noted that clean up criteria have not been established and remediation of the entire shaded area may not be required.

Five borings were made in this area and six soil samples were obtained and analyzed (Figure 7.7). The sample depth ranged from the surface to a maximum of five feet (approximate depth to groundwater). The results indicated no volatile organics were present in the soils except for toluene at 0.012 mg/kg in SB-10. Total petroleum hydrocarbons were found in each sample at concentrations ranging from 17 mg/kg to 36,000 mg/kg. Based on the TPH results, it appears that this area of the site is contaminated with petroleum products.

Groundwater Sampling Results

During the 1989 and 1990 field investigations monitoring wells and temporary wells were installed to determine groundwater flow direction, monitor for the presence of free floating product and to obtain groundwater samples. This subsection provides the details of the analytical results. The groundwater sampling results for aromatic volatiles and TPH are depicted on Figure 7.8 and a summary of results is provided in Tables 7.2 and 7.3. As discussed in the hydrogeology subsection, groundwater flow is towards the northeast with a slight downward vertical gradient.

In 1989, groundwater samples were obtained from monitoring wells MW-2, MW-3, MW-4, MW-5 and MW-6 (deep well). Results of this sampling event indicated groundwater from well MW-5 contained benzene, ethylbenzene and xylenes at low levels. A sample from MW-6 contained TPH and benzene and toluene at estimated concentrations close to detection limits. Groundwater from the other wells did not contain contaminants.

Well MW-6 was resampled on three occasions in 1990 to confirm the presence of contamination identified in 1989. Prior to sampling this well in 1990, the well was

redeveloped and purged in order to confirm that the detection of benzene in 1989 was not present as a result of drilling activities. No volatile organics were detected at this location in the three 1990 sampling events indicating that the original detection is not representative of groundwater contamination at this sampling interval (Table 7.3). Contaminants detected in 1989 were at relatively low concentrations and may have degraded to below detection limits. Based on the results obtained from MW-6, the installation and sampling of additional deep monitoring wells was not necessary to characterize the contaminant plume at Site 3/6.

Monitoring well MW-1, installed and sampled during the 1987 SI, was sampled for the second time during 1990. Results from the most recent sampling effort indicate the groundwater contains benzene (1200 μg/L), ethylbenzene (260 μg/L), toluene (4900 μg/L), xylene (1,700 μg/L) and TPH (17 mg/L). These concentrations of BETX all exceed the Wisconsin Preventive Action Limits and Enforcement Standards for concentrations in groundwater. Monitoring well, MW-1, was originally sampled during the 1987/1988 SI conducted at Site 3/6. Benzene, toluene and xylenes were detected at 1.6, 1.6 and 29.9 μg/L, respectively [ES, 1990c]. The concentrations of BETX found during the 1990 sampling effort are significantly higher than concentrations detected in 1987. Exploratory hand augering, previously discussed in the Soil Sampling Results subsection, was executed in 1991 to identify the source of groundwater contamination at MW-1. The results indicate a possible contaminant source under the aboveground storage tanks at Site 6. The two-well cluster downgradient of MW-1 was sampled in 1990 and shown not to contain contaminants.

Monitoring well MW-5 was sampled in 1989 and contained benzene (7.0 μg/L), ethylbenzene (2.2 μg/L) and xylene (5.3 μg/L). The 1990 sample from this well did not contain volatiles or TPH above detection levels. This well is located between a suspected source near Buildings 32 and 30 and well MW-1.

Based on field observations and headspace readings obtained during exploratory borings, two temporary wells were installed and two monitoring wells (MW-7 and MW-8) were installed near suspected sources of groundwater contamination and sampled in 1990 (Figure 7.8).

The temporary wells were installed to determine if free floating product was present on the water table. A water sample collected for headspace analysis from TW-2, located near Building 33, separated into two phases upon sitting. The organic phase was approximately 1/8 inch thick. TW-2 was then tested with an oil/water probe; however, no separate phase was detected. Temporary well TW-1 was located in an area with high headspace readings. No free floating product was encountered at this location. This well is located further north than other wells and therefore, a sample was obtained for analysis. Toluene (170 μg/L) and TPH (1.2 mg/L) were present in the sample collected from TW-1. Toluene at this

concentration exceeds the Wisconsin Preventive Action Limit of 68.6 μg/L. The sample collected from monitoring well MW-7 southeast of TW-1 also contained toluene but only at 1.2 μg/L.

The sample obtained from MW-8 (Figure 7.8) contained aromatic volatiles above Preventive Action Limits and Enforcement Standards. Compounds detected include benzene (2,200 μg/L), ethylbenzene (130 μg/L), xylene (130 μg/L) and TPH (1.8 mg/L). This well is located downgradient of the southernmost area of expected soil contamination (Figures 7.6 and 7.7). Monitoring well MW-2, located downgradient of MW-8, was sampled in 1989 and 1990. No contaminants were detected in these samples. The estimated extent of groundwater contamination at Site 3/6 is also presented on Figure 7.8.

Lead was detected in one groundwater sample collected in 1989. Well MW-6, the deep well, was found to contain lead (11 μg/L) above the Preventive Action Limit of 5 μg/L but below the Enforcement Standard (50 μg/L). Lead was not found above the detection level in the sample obtained from this well in 1990. TDS values for all samples obtained in 1989 and 1990 ranged from 65 mg/L to 330 mg/L (Tables 7.2 and 7.3).

BASELINE RISK ASSESSMENT

The following subsection presents the risk assessment conducted for Site 3/6. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the risk assessment. The risk assessment presented here was conducted according to the most recent EPA guidelines. Analytical results for soil and groundwater samples from the 1987 SI [ES, 1990c] were used along with the 1989 and 1990 analytical results in the preparation of this risk assessment. The 1987 data is presented in Appendix G.

Selection of Chemicals of Concern

BETX, TPH, and lead were detected in soils and groundwater samples associated with Site 3/6. Based on the chemicals detected in 1987/1988, 1989 and 1990, rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected for each medium. The available toxicity information for the chemicals detected at this site is presented in Section 4 and Appendix F.

Soils

Ethylbenzene, toluene, xylene, lead, and TPH were retained as chemicals of concern in surface and deep soils associated with Site 3/6. The arithmetic average, standard deviation and 95 percent UCL for each chemical are presented in Tables 7.4 (surface soils) and Table 7.5 (deep soils). In addition to the soil samples analyzed in 1990 (Table 7.1) soil samples were also collected in 1987/1988 (one

surface and two deep soil samples) and used in this risk assessment. The 1987/1988 data is presented in Appendix G.

Groundwater

Benzene, ethylbenzene, toluene, xylene, lead and TPH were detected in the groundwater samples obtained at Site 3/6. All of these compounds were retained as chemicals of concern with the exception of lead, which was not detected at a concentration greater than three times PQL for lead in the upgradient well. The arithmetic average, standard deviation and 95 percent UCL for each chemical are presented in Table 7.6. This table also includes results obtained from the sampling of well VF 3/6 MW-1 in 1988 (see Appendix G).

Human Health Evaluation

The human health evaluation is presented in the following subsections.

Exposure Pathways

Potential sources for contaminant release at this site include the fuels spilled at the site and any soils or groundwater in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 3/6 are soils at the site (both on the surface and at depth) and groundwater at and downgradient of the site. Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point.

Access to Site 3/6 is restricted by fencing. The only personnel present at the site are one or two base workers, the truck drivers who come to refuel their vehicles, and an occasional base contractor. Highway H and a railroad spur run along the southwest side and adjacent to the base boundary. The site is covered with sparse to thick vegetation and some concrete.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 3/6 are summarized in Table 7.7.

Soils. Current pathways involving incidental ingestion of and dermal contact with surface and deep soils at Site 3/6 are unlikely but possible for onsite workers. In the unlikely event that a residence was constructed at Site 3/6, both oral and dermal contact with soils by hypothetical residents would be more likely to occur. Hypothetical (future) workers could also be exposed to site soils. There were no carcinogenic risks calculated for exposure to soils at this site because the only carcinogen detected in site soils was lead, which does not have an EPA approved slope factor. The lead concentrations can be qualitatively assessed by comparing them to the USEPA's risk based target for lead in soils (i.e., 500 mg/kg). This

comparison reveals that the highest lead concentration detected in site soils was orders of magnitude less than the clean-up target and should not therefore present an unacceptable risk.

Groundwater. Since chemicals were detected in monitoring wells immediately downgradient of the site, contamination of further downgradient supply wells is possible (in the future). Exposure could occur via ingestion of groundwater, dermal contact with groundwater during showering, and inhalation of volatile organic compounds released from groundwater during showering. The oral pathways would apply to future employees as well as residents. The dermal and inhalation pathways would apply mainly to future residents who might shower or bathe with the contaminated groundwater.

Surface Water. Site 3/6 lies within the Lemonwier River drainage basin. However, since the river is more than 2 miles from the site, contamination in surface runoff from the site is not likely to reach the river in detectable concentrations. Therefore, this pathway will not be considered further.

Air. Since VOCs were detected in soil samples taken from Site 3/6, it is possible that exposure could occur via inhalation of these compounds released in air. Current exposures would be primarily to workers who drive through the site, nearby residents, and base workers in areas downwind of the site. Given the low concentrations of VOCs present in soils, the concentrations released to air are probably quite low, particularly for residents and employees who are not located on the site. The worst-case exposure scenario would be for a hypothetical future resident who might build a house at the site.

Similarly, exposures via inhalation of inorganic and semivolatile organic contaminants released to air via wind erosion of surface soils could occur. The vegetation and concrete which exists on site would serve to retard wind erosion. Although current exposures (base employees and downwind residents) are expected to be very low, exposure is theoretically possible. If someone were to construct a house on site, exposure via airborne contaminants released from both surface soils and deeper soils (exposed during construction of the residence) could occur.

In this assessment, exposure concentrations, exposure intakes (oral and dermal pathways only), and subsequent risks and hazard indices were calculated for the following pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of surface soils	Children	7.8	7.9
	Workers	7.10	7.11
	Adult residents	7.12	7.13
Dermal contact with surface soils	Children	7.14	7.15
	Workers	7.16	7.17
	Adult residents	7.18	7.19
Ingestion of deep soils	Children	7.20	7.21
	Workers	7.22	7.23
	Adult residents	7.24	7.25
Dermal contact with deep soils	Children	7.26	7.27
	Workers	7.28	7.29
	Adult residents	7.30	7.31
Ingestion of groundwater	Children	7.32	7.33
	Workers	7.34	7.35
	Adult residents	7.36	7.37
Dermal contact with groundwater(1)	Children	7.38	7.39
	Adult residents	7.40	7.41
Inhalation of VOCs released from groundwater during showering(1)	Children	7.42	7.43
	Adult Residents	7.44	7.45

(1) Workers were not considered to be exposed to contaminants in groundwater via showering (dermal and inhalation) because showering is assumed to take place at their homes.

Exposure to contaminants released to air from soils were not quantified since the risks associated with these pathways would be orders of magnitude lower than those associated with oral and dermal exposure. Low risks are anticipated for air pathways because the concentrations of contaminants in soils are low and the site is partially covered by vegetation and concrete. In addition, releases to the air by volatilization or wind erosion would be mitigated by dispersion and degradative processes. For example, the VOCs detected in soils (toluene, ethylbenzene, xylenes) have short half-lives in air ranging from 2.6 hours to 1.8 days (xylene) to 10 hours to 4.3 days (toluene) [Howard et al., 1991].

Risk Characterization

Carcinogenic Risks

A summary of the carcinogenic risks for each receptor is provided in Table 7.46. The calculated risks for each environmental medium and exposure pathway are discussed below.

Soils. Lead was the only carcinogenic compound detected in soils. Risks associated with exposure to lead cannot be calculated since there is no slope factor

for lead. However, since the lead concentrations detected in soils (0.57 to 14 mg/kg) were well below EPA's risk-based target concentration for lead in soil (500 mg/kg), risk associated with ingestion, dermal contact with or inhalation of lead should be well below EPA's target risk range of one-in-one-million (1E-06) to one-in-ten-thousand (1E-04).

Groundwater. Carcinogenic risks were evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from the groundwater during showering.

(1) Ingestion. The calculated carcinogenic risk exceeded EPA's acceptable risk range for hypothetical (future) adults and children residing at the site. The calculated risk for both adults and children was 2E-4 or 2 excess lifetime cancer cases in ten thousand exposed. These risks are entirely caused by the presence of benzene.

(2) Dermal Absorption. Dermal absorption was evaluated for hypothetical (future) site residents (adults and children) and the calculated risks were less than EPA's acceptable risk range. Thus, the calculated carcinogenic risks for this exposure do not indicate unacceptable health risks.

(3) Inhalation of VOCs. The inhalation of volatile organic compounds released from groundwater was assessed for exposures to hypothetical (future) site residents (both children and adults). The calculated risks for these hypothetical (future) receptors were 3E-4 (children) and 2E-3 (adults). The risks correspond to 3 excess lifetime cancer cases per 10,000 exposed and 2 excess lifetime cancer cases per 1,000 exposed, respectively. Both of these calculated risks exceed EPA's acceptable risk range. Benzene was the contaminant entirely responsible for these elevated risks.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was also assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 7.47. A hazard index which exceeds 1 is an indication that adverse health effects are likely. The hazard index for each environmental medium and exposure pathway are discussed below.

Soils. The hazard indices for all soil exposure pathways and receptors were much less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e, residential use of the site), the calculated hazard indices for soil pathways at Site 3/6 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Groundwater. Noncarcinogenic health hazards were also evaluated for three exposure pathways associated with groundwater contamination at this site. These

exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from groundwater during showering.

(1) Ingestion. The hazard index for children ingesting site groundwater equals 1 and indicates that adverse health effects could occur if the hypothetical (future) exposure did, in fact, occur. The chemical contaminant responsible for this index was toluene. The hazard indices for adults and on-site workers did not exceed 1 and therefore a potential health hazard should not exist for these groups of hypothetical (future) receptors.

(2) Dermal Absorption. Dermal absorption was evaluated for hypothetical (future) site residents (adults and children) and the calculated hazard indices for these potential receptors were much less than 1. Thus, this exposure route/pathway does not represent a health hazard, even with conservative residential assumptions used in the assessment.

(3) Inhalation of VOCs. The inhalation of VOCs released from groundwater during showering was also assessed for exposures to hypothetical (future) site residents (adults and children). The calculated hazard indices for these potential receptors were greater than 1 and indicate that adverse health effects could occur if the hypothetical (future) exposure did, in fact, occur. The chemical contaminants responsible for these indices were toluene and xylene.

Ecological Evaluation

Site 3/6 is classified as a grassland. Stands of northern hardwoods, aspen, jack pine, red pine and oak, and a marshy area are directly north of the site. Ecological receptors living in these habitats are summarized in Section 4. In addition to these receptors, orange prairie, (a dry mesic community listed as an endangered resource in the State of Wisconsin), is found along the railroad tracks.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 3/6 could include:

- ingestion and dermal contact with contaminants in soils, particularly for burrowing species of animals;
- uptake of contaminants in soils by plants;
- uptake of contaminants in groundwater by plants;
- uptakes of contaminants in surface water by plants;
- inhalation of VOCs released from contaminated soils by terrestrial and avian species; and
- ingestion of bioaccumulated contaminants in plants and animals by other animals higher in the food chain.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is covered with vegetation and concrete. Inhalation exposures resulting from VOCs released from soils are unlikely to be significant due to the low concentrations detected and limited source area. The orange prairie along the railroad tracks is upgradient of the site, and is therefore unlikely to be exposed to contaminants in groundwater or soils.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in groundwater and soils. However, toxicity values are available to evaluate compounds detected in soils associated with Site 3/6 and are presented in Table 4.10. These values include acute oral LD50s for mammals. It should be noted that these values can be used only in a qualitative way to screen chemicals of concern to determine if potential adverse ecological impacts are possible. Acute LD50 values can only be used to highlight which of the detected chemicals might be toxic to mammals. There are no similar criteria for plants or birds.

Risk Characterization

There is no surface water associated with Site 3/6 but a marshy area does exist to the north (downgradient) of the site. No surface water samples were collected from the marsh; however, contaminants were not detected in the furthest downgradient monitoring well for Site 3/6. Therefore, it is unlikely contaminants related with groundwater and soils at the site are impacting the marshy area.

There are no toxicity values with which to evaluate exposure of flora and fauna to chemicals in groundwater. However, a method of screening the relative toxicity of a chemical detected in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils (i.e., lead, ethylbenzene, toluene, and xylenes). Lead is the only compound detected in soils which is severely acutely toxic to mammals. The ethylbenzene, toluene and xylenes detected in soils at Site 3/6 are classified as slightly toxic with respect to acute oral toxicity. It is not possible (based on currently available toxicological information) to determine whether the concentrations detected in soils onsite are high enough to cause adverse ecological effects.

Risk Assessment Conclusions

The conclusions and uncertainties of the baseline risk assessment are provided in this subsection.

Human Receptors

BETX, TPH and lead were detected in surface soils, deep soils and groundwater at Site 3/6. The only current human exposure pathways which could

possibly occur are incidental ingestion of and dermal contact with surface soils by Base workers. Hypothetical (future) exposure pathways which are possible if someone were to build a house at the site include ingestion of and dermal contact with contaminants in groundwater, ingestion of and dermal contact with contaminants in both surface and deep soils, and inhalation of VOCs released from groundwater during showering. Hypothetical (future) workers could also ingest and have dermal contact with contaminants in surface and deep soils. Inhalation pathways associated with VOCs and lead in surface soils are possible but were not calculated since risks associated with these pathways are expected to be orders of magnitude lower than those associated with the oral and dermal pathways.

The unacceptable risks associated with Site 3/6 are:

- carcinogenic risks associated with ingestion of groundwater by hypothetical residents (benzene);
- carcinogenic risks associated with inhalation of benzene released from groundwater during showering by hypothetical residents;
- noncarcinogenic risks associated with ingestion of groundwater by hypothetical (children) residents (toluene); and
- noncarcinogenic risks associated with inhalation of xylene released from groundwater during showering by hypothetical residents.

An important assumption made in this risk assessment is that contaminant concentrations will remain constant and no decrease over a long period of time, up to 30 years. However, organic compounds especially benzene, detected in both soils and groundwater do degrade with time. This would result in an overall decrease in contaminant concentrations.

It should be noted that any potential risks associated with TPH and lead in soils were not quantified in this assessment due to the lack of reference toxicity values. However, the risks associated with lead at Site 3/6 are expected to be very low since the concentrations detected in soils are well below EPA's target lead concentration (500 mg/kg) for lead in soils in Superfund sites [EPA, 1989b]. This target concentration was based on multi-route exposure to lead contaminated soils, given a blood level of concern of 10 to 15 μg/dl. No similar criteria are available for TPH.

A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4. No further uncertainties apply to this assessment.

Ecological Receptors

Flora and fauna could be exposed through uptake of chemicals detected in soils and groundwater. It is not possible to characterize risks associated with contaminants detected at Site 3/6 due to the lack of approved reference toxicity information for ecological receptors. However, toxicity values are available to qualitatively evaluate compounds detected in soils. Based on mammalian LD50

values for acute exposures, lead is the only compound in soils which is severely toxic to mammals.

CONCLUSIONS

Contaminants were identified in both soils and groundwater at Site 3/6. The contaminated soils serve as a continuous source of groundwater contamination and ARARs for groundwater were exceeded. The risk assessment performed at this site indicates that contaminated groundwater poses an unacceptable risk to human health.

Contamination was found in the fuels handling areas and in the northern area of Site 3/6. The maximum TPH concentration found was 36,000 mg/kg. In the surface storage area, TPH concentrations were detected in the percentage range. Buildings 30 and 33 are the two major areas of soils contamination detected in the fuels handling area. High TPH and aromatic volatiles were detected adjacent to each building. Contaminants at low concentrations were detected in samples collected from the areas where USTs have been excavated. Elevated headspace readings were also found in the aboveground tank fuel spill area during this investigation. A possible source for the groundwater contamination may exist under these aboveground tanks.

The magnitude and extent of groundwater contamination at Site 3/6 has been evaluated with eight monitoring wells and two temporary wells. Although there is a slight downward gradient in the groundwater flow system, contamination appears to be confined to the upper portions of the aquifer. The areal extent of contamination appears to be greatest downgradient of the fuel handling area (Site 3). A thin layer of free floating product is present in the area of Building 33. Well MW-8 is located downgradient of the area where free floating product was encountered. Groundwater from this well had the highest detected level of benzene. Well MW-2, further downgradient of this location, is not contaminated.

Groundwater contamination was encountered in the area of stressed vegetation north of Site 3. Although there is no monitoring well located downgradient of this area, the horizontal extent is probably limited as the contamination near the source is minor.

Groundwater contamination in the area of the aboveground tank fuel spill area (Site 6) has been characterized by well MW-1. Significant contamination was detected here in 1990. Limited hand augering in this area in 1991 indicate that a source for this contamination may be located below the aboveground tanks. A well cluster downgradient of this location is not contaminated.

The compounds detected in soils and groundwater at Site 3/6, including those detected during the 1988 sampling effort [ES, 1990c], are presented in Table 7.48. This table also provides a comparison of the maximum detected concentrations to ARARs introduced in Tables 4.1 through 4.4. ARARs exceeded at this site include

the Wisconsin Enforcement Standard and the Federal MCL. ARARs for soils were not identified; however, To-Be-Considered criteria for soils are presented in Section 4. Compounds detected in groundwater which exceeded ARARs include benzene, toluene, and xylenes.

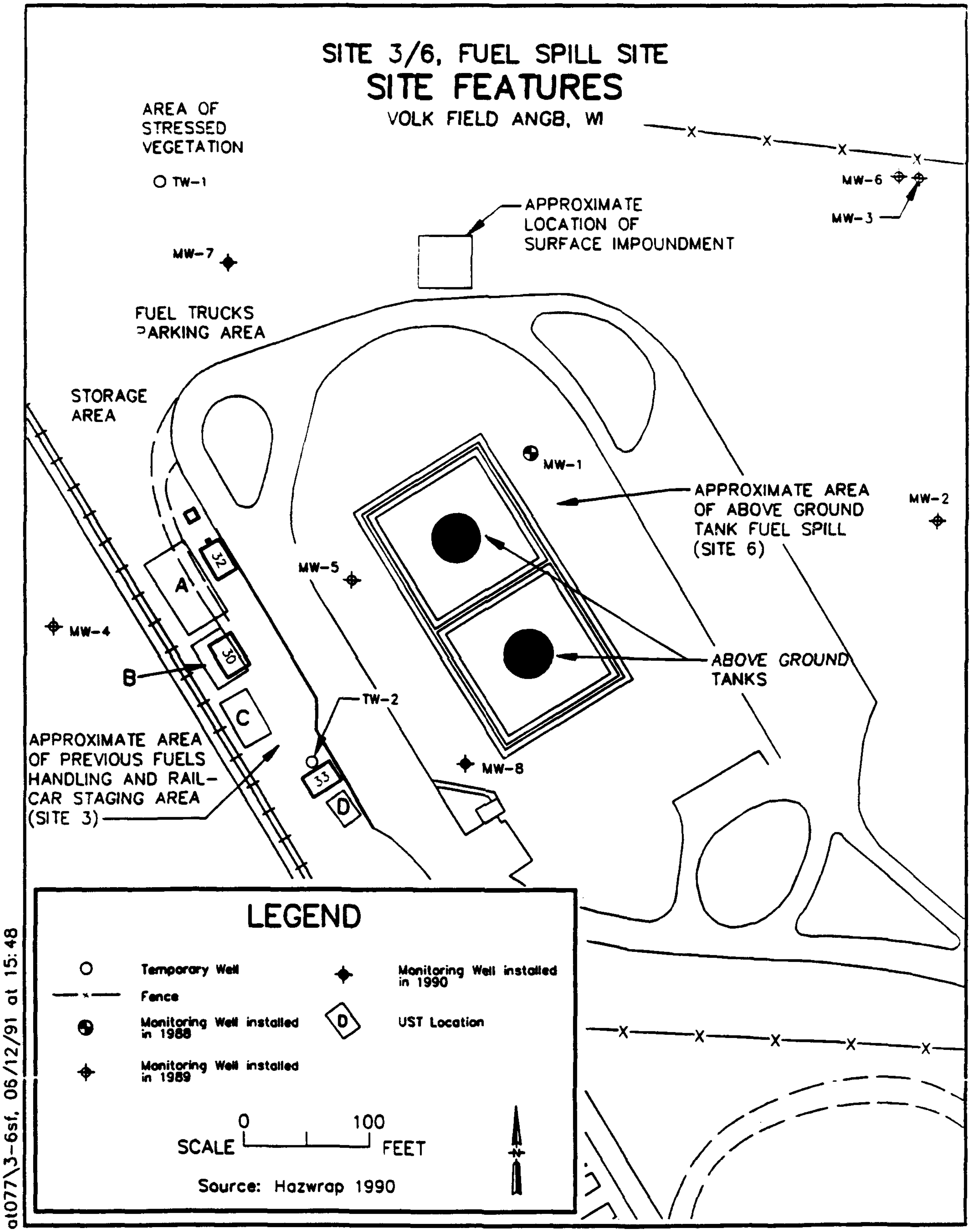
The pathways for exposure considered at Site 3/6 included the incidental ingestion of and dermal contact with surface and deep soils, ingestion of groundwater, dermal contact with groundwater, and inhalation of volatiles from groundwater. The risk associated with soils (both surface and deep) were found to be acceptable for all receptors. Carcinogenic risks associated with ingestion of groundwater and inhalation of volatiles released from groundwater during showering were found to be unacceptable for hypothetical residents. These risks are due to the presence of benzene. Noncarcinogenic risks associated with ingestion of groundwater (toluene) and inhalation of VOCs released from groundwater during showering (toluene and xylene) were found to be unacceptable for hypothetical residents. It is noted, however, that pathways associated with groundwater at this site are not considered complete at this time. This pathway could become complete only if contaminants were to migrate to downgradient drinking water wells or if a drinking water well were installed at the site.

RECOMMENDATIONS

Given the contaminant concentration in the soils at Buildings 30 and 33 in the previous fuels handling area, action should be undertaken to remove these continuing sources of groundwater contamination. The source of contamination at Site 6 should be confirmed. If contaminant concentration in the soils in this location are significant, action should be undertaken to remove the source of groundwater contamination here as well. In accordance with the NCP, removal actions include appropriate actions that will minimize the migration of hazardous substances into the soil or groundwater. An evaluation of the alternatives and resources available should be made to determine the best means of removing the various sources of groundwater contamination.

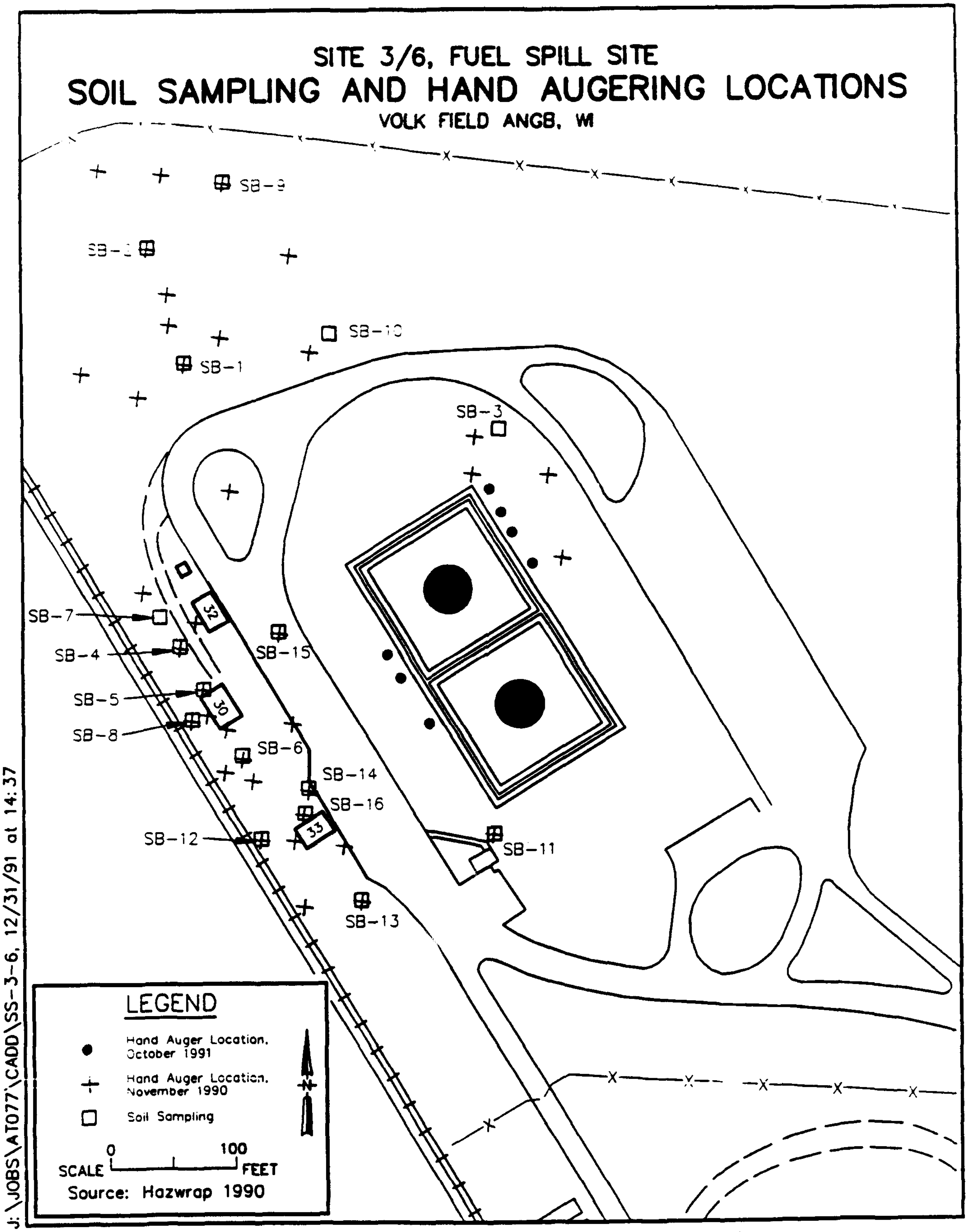
An FS should be conducted to address the soil and groundwater contamination across the site. The FS would assess potential remedial actions (including the no-action alternative). Additional soil sampling may be required to evaluate treatment options for soils remediation. Potential remedial alternatives including extraction and treatment should be considered for groundwater remediation. Additional aquifer testing may be required.

Figure 7.1

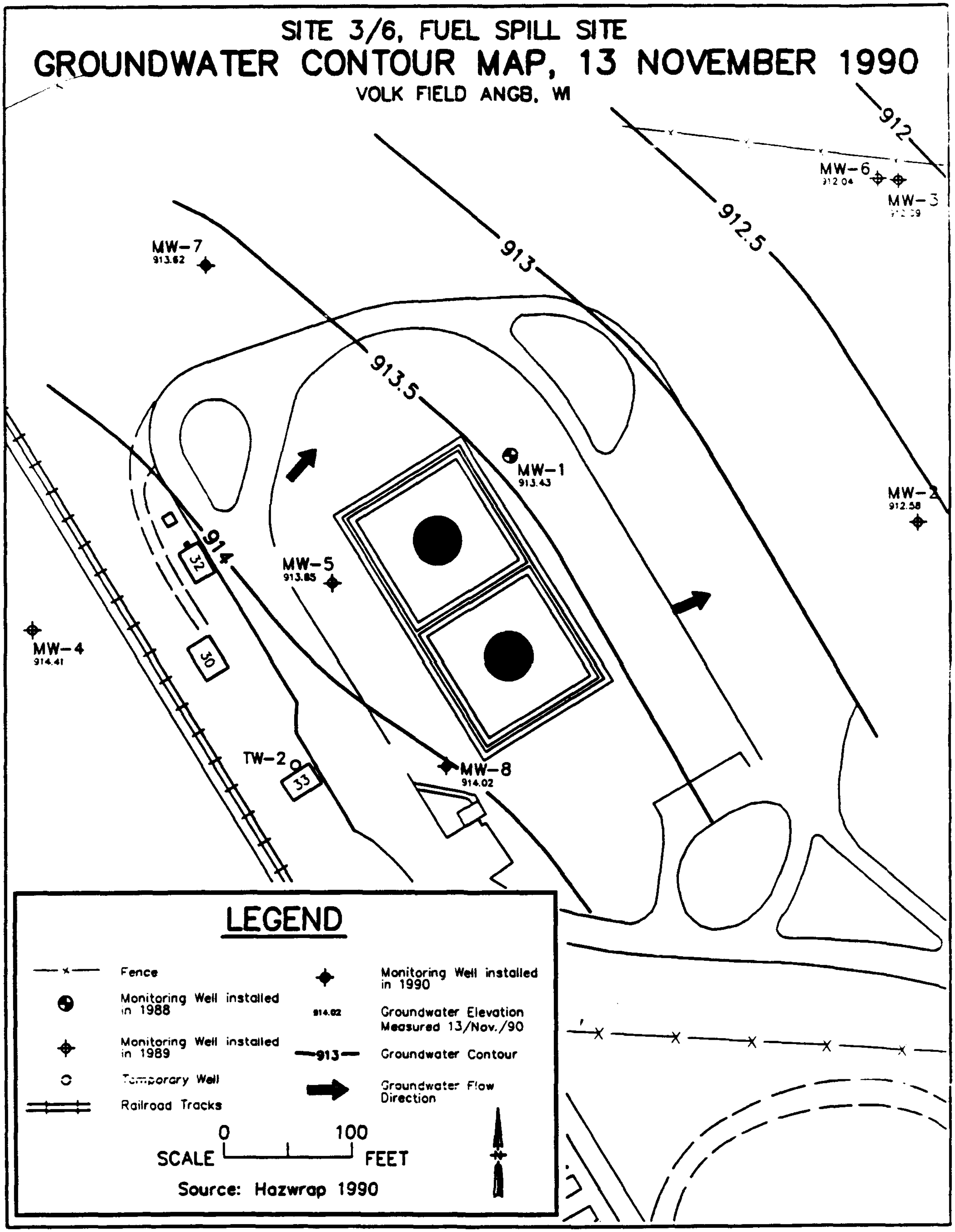


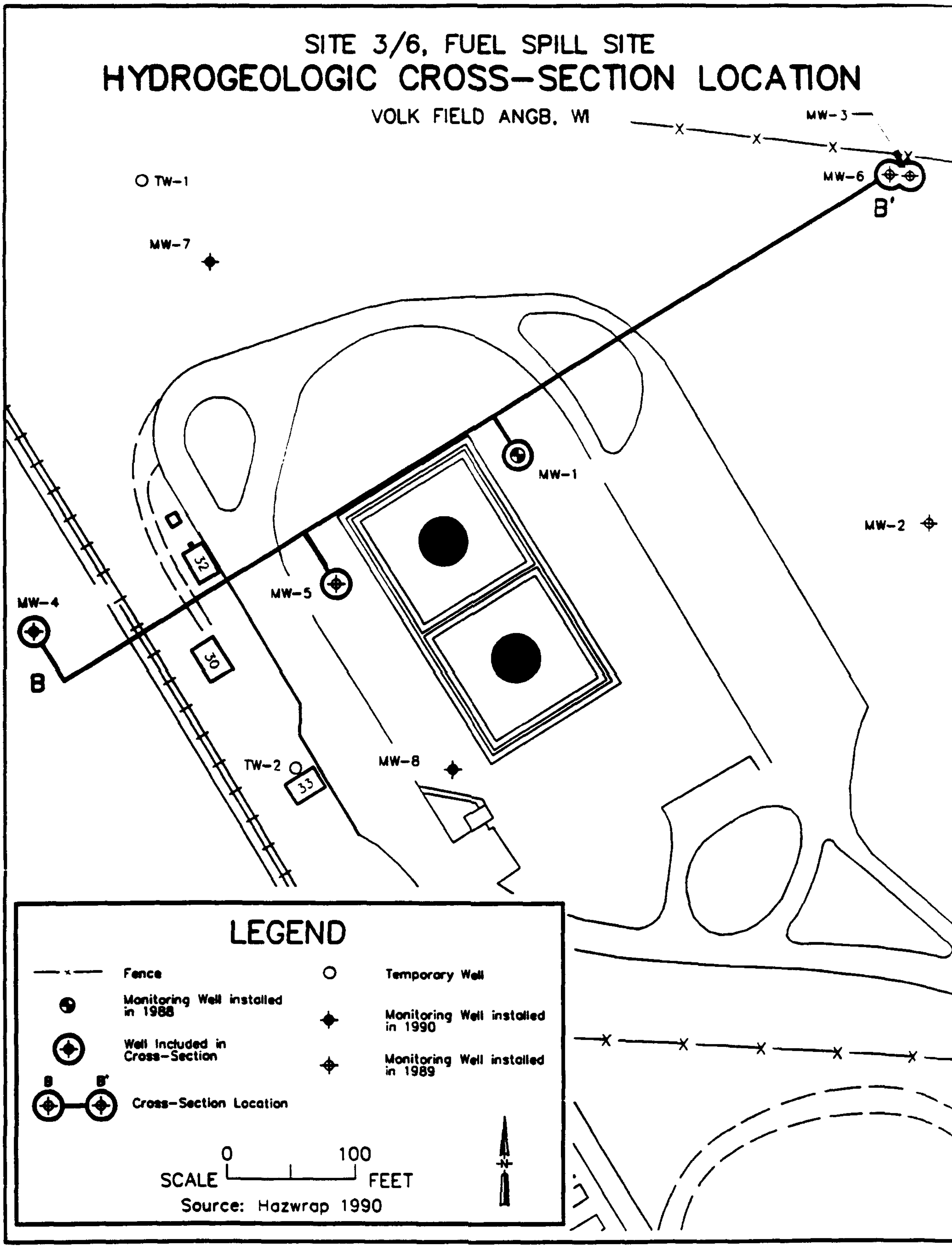
ENGINEERING-SCIENCE

Figure 7.2

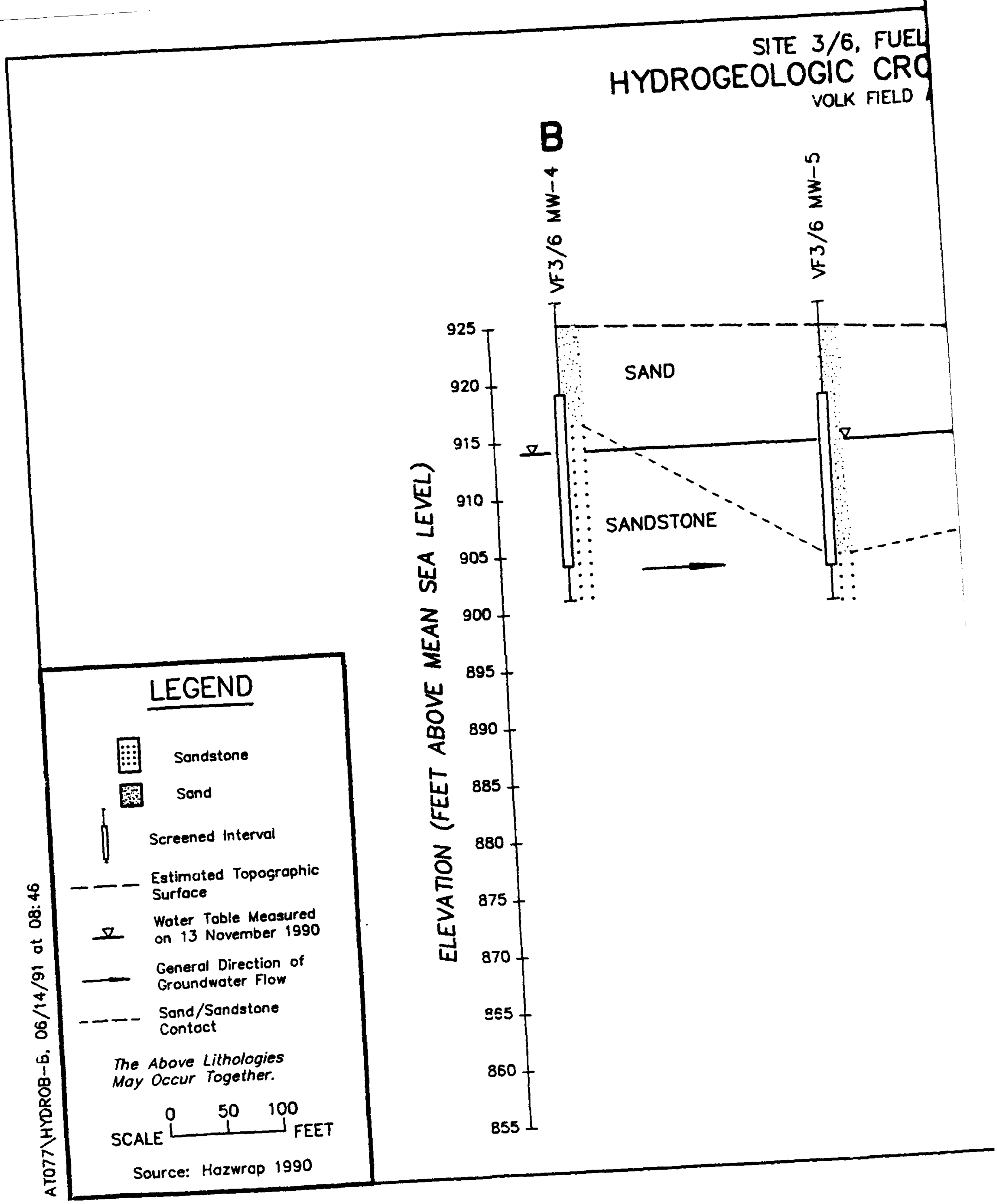


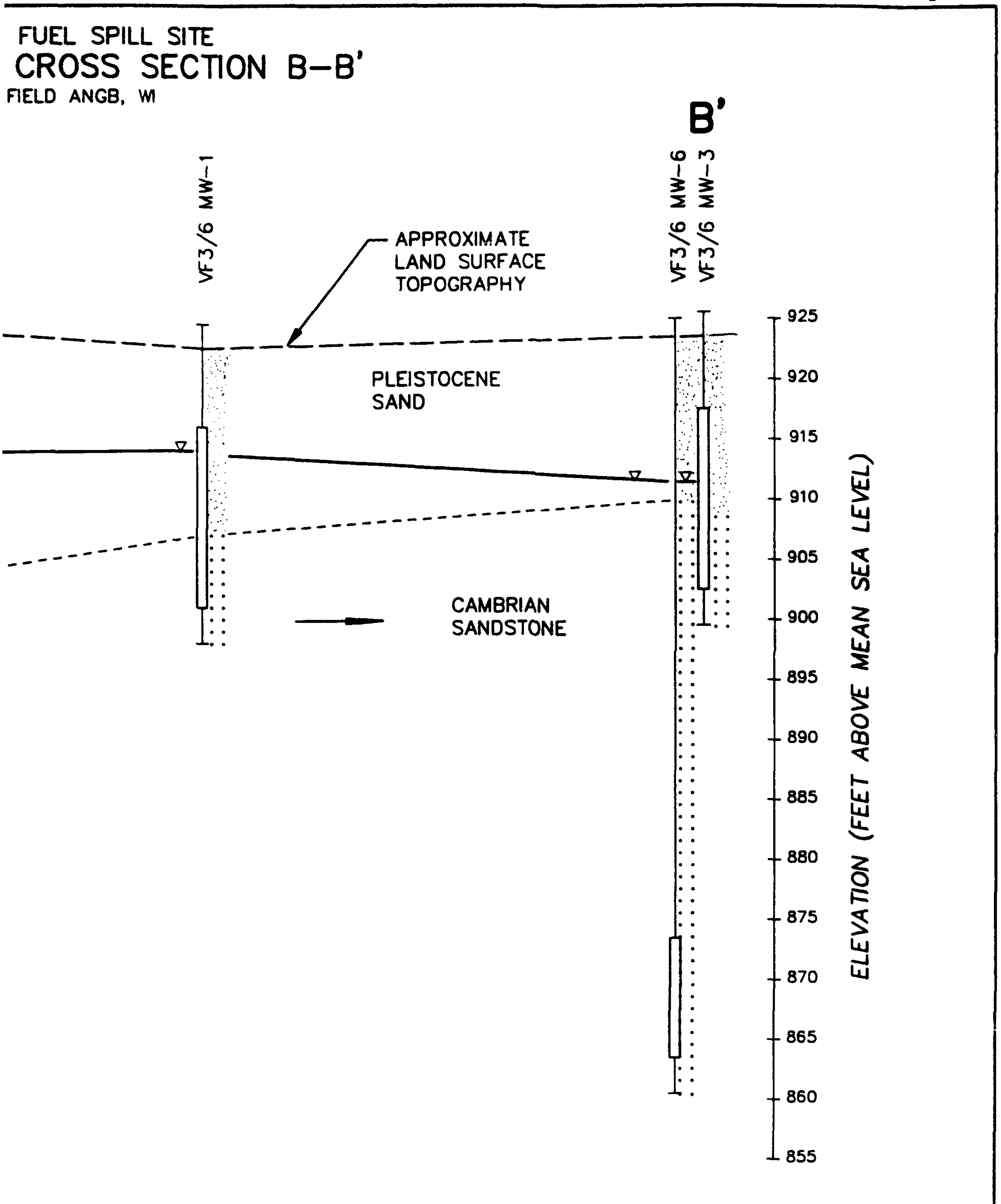
ENGINEERING-SCIENCE


SITE 3/6, FUEL SPILL SITE
GROUNDWATER CONTOUR MAP, 13 NOVEMBER 1990
VOLK FIELD ANGB, WI
912
912.5
913
913.5
914
MW-6
912.04
MW-3
MW-7
913.62
MW-1
913.43
MW-2
912.58
MW-5
913.85
MW-4
914.41
TW-2
MW-8
914.02
32
30
33
LEGEND
Fence
Monitoring Well installed in 1988
Monitoring Well installed in 1989
Temporary Well
Railroad Tracks
Monitoring Well installed in 1990
914.02
Groundwater Elevation Measured 13/Nov./90
913
Groundwater Contour
Groundwater Flow Direction
0
100
SCALE
FEET
N
Source: Hazwrap 1990
J:\JOBS\AT077\CADD\S-1MW, 01/24/92 at 18:44

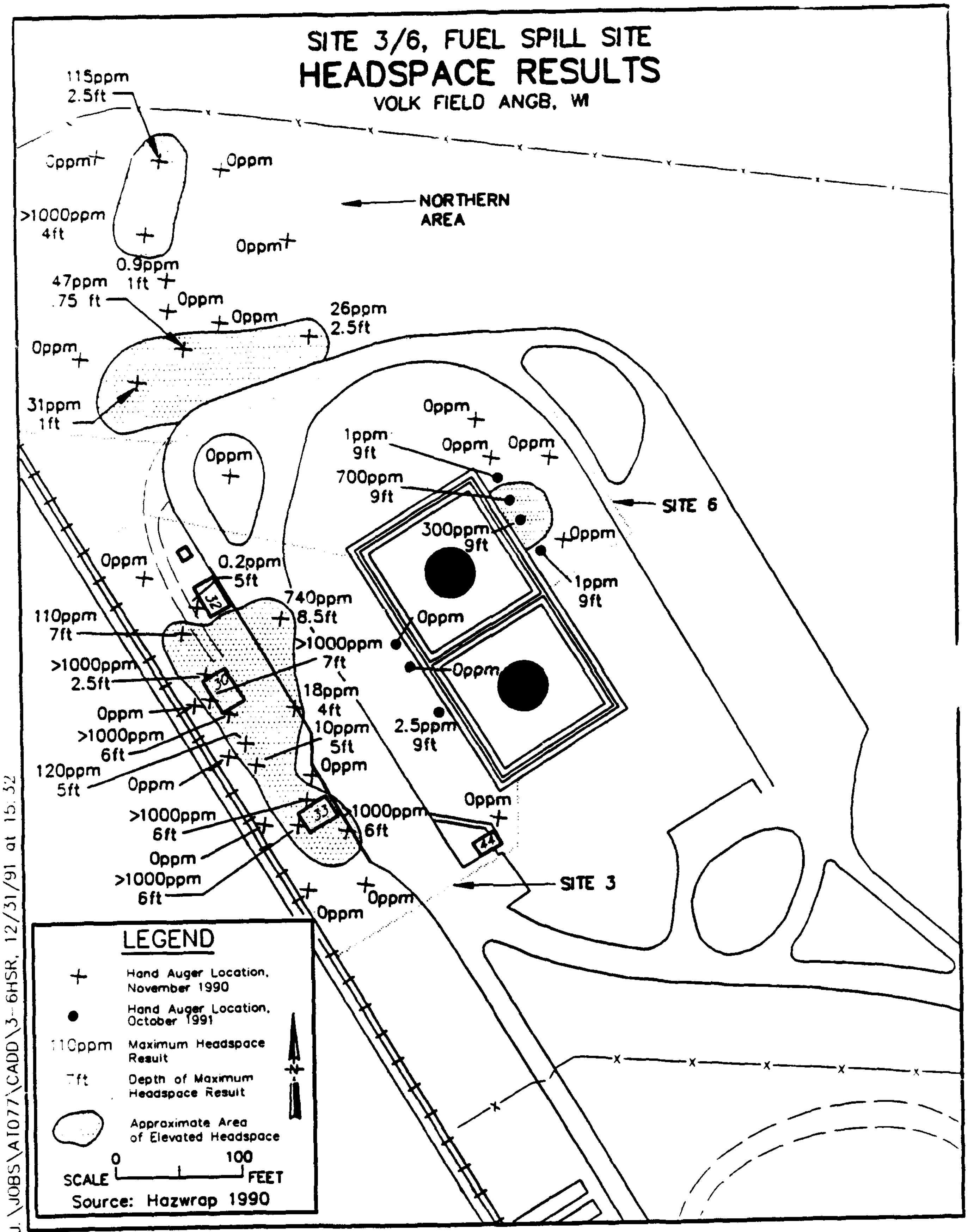


at077\crossb-b, 06/12/91 at 15:48


SITE 3/6, FUEL
HYDROGEOLOGIC CRO
VOLK FIELD
B
VF3/6 MW-4
VF3/6 MW-5
SAND
SANDSTONE
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
925
920
915
910
905
900
895
890
885
880
875
870
865
860
855
LEGEND
Sandstone
Sand
Screened Interval
Estimated Topographic Surface
Water Table Measured on 13 November 1990
General Direction of Groundwater Flow
Sand/Sandstone Contact
The Above Lithologies May Occur Together.
0
50
100
SCALE
FEET
Source: Hazwrap 1990
AT077\HYDROB-6, 06/14/91 at 08:46

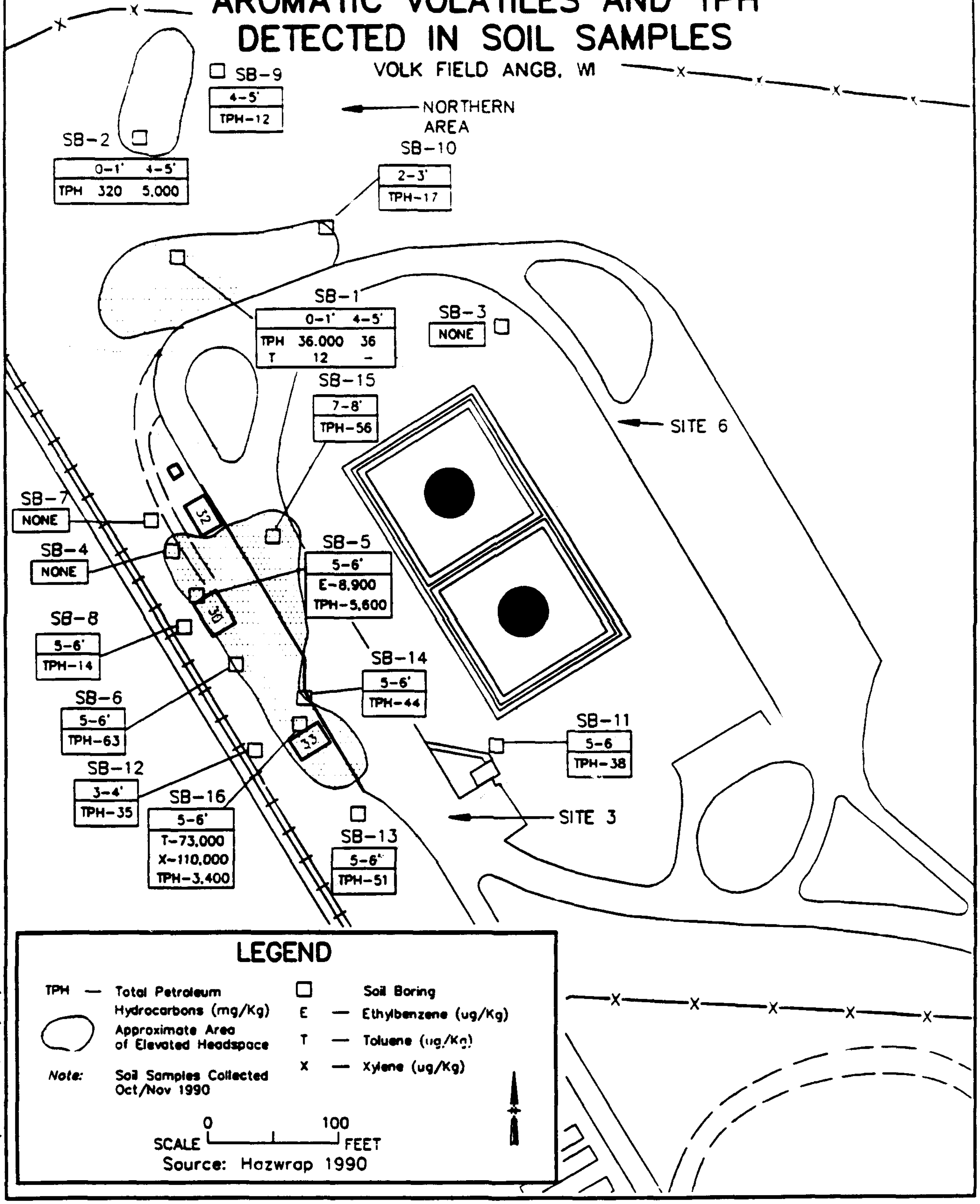


ES ENGINEERING-SCIENCE



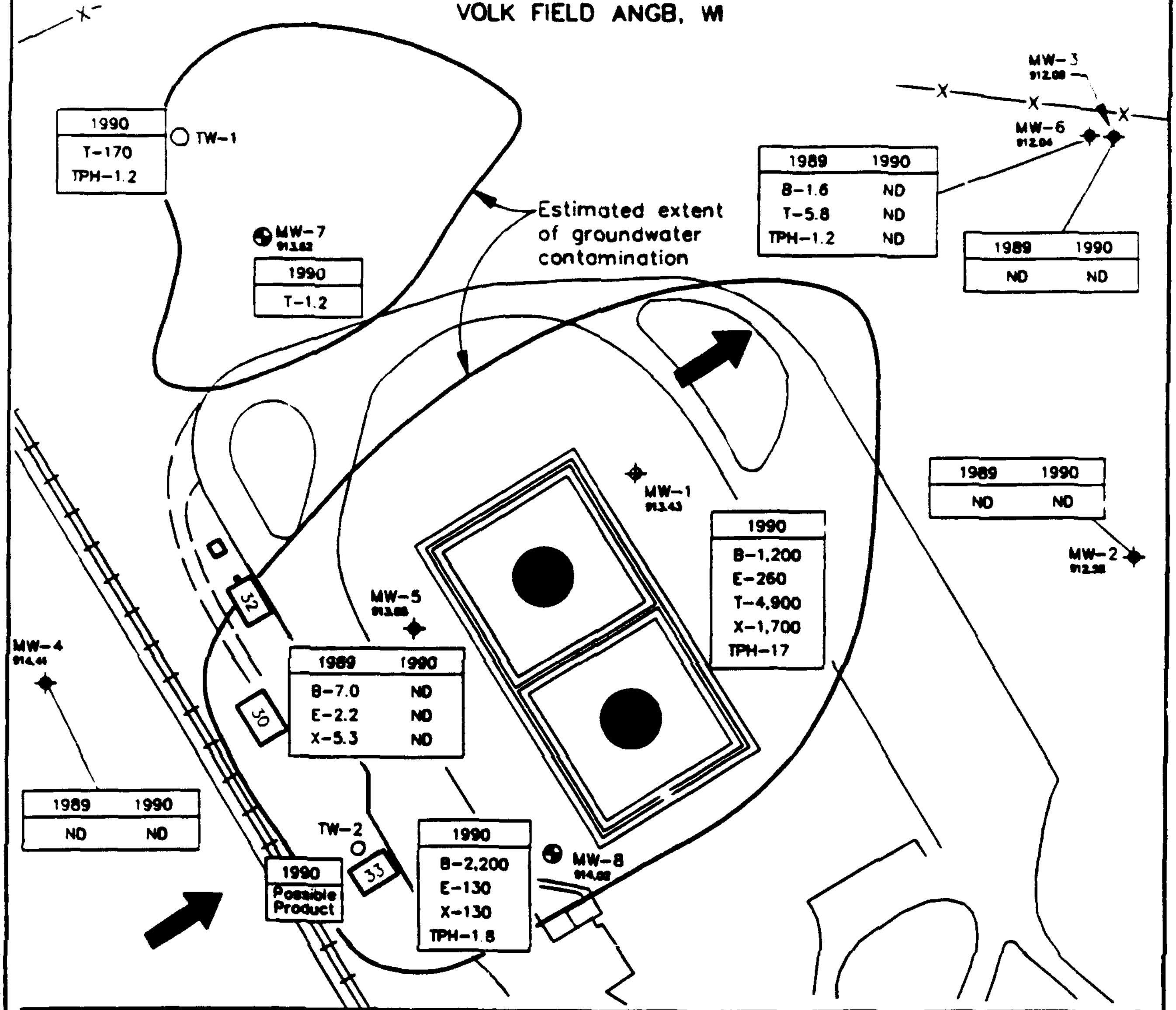
ENGINEERING-SCIENCE

SITE 3/6, FUEL SPILL SITE
AROMATIC VOLATILES AND TPH DETECTED IN SOIL SAMPLES
VOLK FIELD ANGB, WI



AT077\3-VTPH, 06/11/91 at 13:47

SITE 3/6, FUEL SPILL SITE
AROMATIC VOLATILES AND TPH DETECTED IN GROUNDWATER SAMPLES
VOLK FIELD ANGB, WI



LEGEND

—x—	Fence
○	Temporary Well Installed in 1990
⊕	Monitoring Well
✦	Monitoring Well Installed in 1990
914.62	Groundwater Elevation Measured 13/Nov/90
➡	Approximate Direction of Groundwater Flow

B	—	Benzene (ug/L)
E	—	Ethylbenzene (ug/L)
T	—	Toluene (ug/L)
X	—	Xylene (ug/L)
TPH	—	Total Petroleum Hydrocarbons (mg/L)
ND	—	Not Detected

SCALE 0 100 FEET

Source: Hazwrap 1990

J:\JOBS\AT077\CADD\3VOL. 02/16/92 at 10:20

TABLE 7.1
SITE 3/6, FUEL SPILL SITE
DETECTED ANALYTES IN SOIL SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF3/6 SB1 (0'-1')	VF3/6 SB1 (4'-5')	VF3/6 SB2 (0'-1')	VF3/6 SB2 (4'-5')	VF3/6 SB3 (0'-0.5')	VF3/6 SB3 (5'-6')	VF3/6 SB4 (0'-0.5')	VF3/6 SB4 (6'-7')	VF3/6 SB5 (5'-6')	VF3/6 SB6-SS1 (5'-6')	VF3/6 SB6-SS11 (5'-6')*	VF3/6 SB7 (5'-6')
Date Sampled	10/14/90	10/16/90	10/14/90	10/16/90	10/14/90	10/16/90	10/14/90	10/16/90	10/16/90	10/16/90	10/16/90	10/17/90
Aromatic Volatiles - SW8020 (ug/kg)												
Ethylbenzene	UJ4	U	U	U	U	U	U	U	8,900	U	U	U
Toluene	12J4	U	U	U	U	U	U	U	U	U	U	U
Xylenes	UJ4	U	U	U	U	U	U	U	U	U	U	U
Total Petroleum Hydrocarbons E418.1 (mg/kg)	36,000	36	320	5,000	12U	11U	11U	11U	5,600	63	67	11U
Lead - SW7421 (mg/kg)	3.8	0.57	5.3	2.6	14	0.87	2.9	0.82	5.6	9.0	9.1	0.74

Parameters	VF3/6 SB8 (5'-6')	VF3/6 SB9 (4'-5')	VF3/6 SB10 (2'-3')	VF3/6 SB11-SS1 (5'-6')	VF3/6 SB11-SS11 (5'-6')*	VF3/6 SB12 (3'-4')	VF3/6 SB13 (5'-6')	VF3/6 SB14 (5'-6')	VF3/6 SB15 (7'-8')	VF3/6 SB16-SS1 (5'-6')	VF3/6 SB16-SS11 (5'-6')*
Date Sampled	10/17/90	10/17/90	10/17/90	11/07/90	11/07/90	11/07/90	11/07/90	11/07/90	11/07/90	11/07/90	11/07/90
Aromatic Volatiles - SW8020 (ug/kg)											
Ethylbenzene	U	U	U	UJ3	UJ3	UJ3	UJ3	UJ3	UJ3	UJ3	UJ3
Toluene	U	U	U	UJ3	UJ3	UJ3	UJ3	UJ3	UJ3	73,000J3	73,000J3
Xylenes	U	U	U	UJ3	UJ3	UJ3	UJ3	UJ3	UJ3	110,000J3	130,000J3
Total Petroleum Hydrocarbons E418.1 (mg/kg)	14	12	17	38	55	35	51	44	56	3,400	2,300
Lead - SW7421 (mg/kg)	1.7	4.0	2.6	1.5J4	1.1J4	2.4J4	0.65J4	0.54J4	10.0J4	1.1J4	1.1J4

U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
* - Duplicate Samples.

TABLE 7.2
SITE 3/6, FUEL SPILL SITE
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF3/6-MW2	VF3/6-MW3	VF3/6-MW4	VF3/6-MW5	VF3/6-MW6
Date Sampled	11/08/89	11/09/89	11/08/89	11/09/89	11/04/89
Aromatic Volatiles - SW8020 (ug/L)					
Benzene	U	U	U	7.0J2	1.6J2
Ethylbenzene	U	U	U	2.2J2	U
Toluene	U	U	U	U	5.8J2
Xylenes	U	U	U	5.3J2	U
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U	U	U	1.2
Total Dissolved Solids E160.1 (mg/L)	160	65	130	260	170
Dissolved Lead - SW7421 (ug/L)	U	U	U	U	11

U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.

TABLE 7.3
SITE 3/6, FUEL SPILL SITE
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF3/6 MW1	VF3/6 MW2	VF3/6 MW3	VF3/6 MW4	VF3/6 MW5	VF3/6 MW6-X1	VF3/6 MW6-X2	VF3/6 MW6	VF3/6 MW7	VF3/6 MW8	VF3/6 MW9(a)	VF3/6 TW1
Date Sampled	11/06/90	10/26/90	10/27/90	10/24/90	10/30/90	09/26/90	10/03/90	10/27/90	10/26/90	10/30/90	11/06/90	11/09/90
Aromatic Volatiles - SW8020 (ug/L)												
Benzene	1,200	U	UJ2	U	U	U	U	UJ2	U	2,200	1,100	U
Ethylbenzene	260	U	UJ2	U	U	U	U	UJ2	U	130J2	260	U
Toluene	4,900	U	UJ2	U	U	U	U	UJ2	1.2	U	4,800	170
Xylenes	1,700	U	U	U	U	UJ2	U	U	U	130J2	1,800	U
Total Petroleum Hydrocarbons E418.1 (mg/L)	17	U	U	U	U	NA	NA	U	U	1.8	14	1.2
Dissolved Lead SW7421 (ug/L)	U	U	U	U	U	NA	NA	U	U	U	U	U
Total Dissolved Solids E160.1 (mg/L)	270	130	4.5	140	250	NA	NA	150	160	170	330	270

NA - Not Analyzed.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
(a) - Duplicate for VF3/6-MW1.

TABLE 7.4
SITE 3/6, FUEL SPILL SITE
CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS (TOP 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	95% Upper Confidence Limit (a) (mg/kg)
Lead	2.9-14	5 / 5	5.78E+00	4.20E+00	1.10E+01
Petroleum Hydrocarbons	310-36000	3 / 5	7.33E+03	1.43E+04	2.51E+04
Toluene	0.012	1 / 5	3.92E-03	4.15E-03	9.07E-03

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 7.5
SITE 3/6, FUEL SPILL SITE
CHEMICALS OF CONCERN DETECTED IN DEEP SOILS (> 2 FEET)
VOLK FIELD ANDG, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	95% Upper Confidence Limit (a) (mg/kg)
Ethylbenzene	0.0066-8.9	3 / 21	4.27E-01	1.89E+00	1.29E+00
Lead	0.54-10.0	21 / 21	2.77E+00	2.95E+00	4.12E+00
Petroleum Hydrocarbons	12-5600	16 / 21	8.05E+02	1.69E+03	1.57E+03
Toluene	73	2 / 21	6.95E+00	2.14E+01	1.67E+01
Xylene	0.047-130	4 / 21	1.14E+01	3.54E+01	2.75E+01

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 7.6
SITE 3/6, FUEL SPILL SITE
CHEMICALS OF CONCERN DETECTED IN GROUNDWATER
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (a) (mg/L)
Benzene	0.00016-2.200	6 / 16	2.82E-01	6.23E-01	6.14E-01
Ethylbenzene	0.0022-0.260	4 / 16	4.12E-02	8.84E-02	8.83E-02
Petroleum Hydrocarbons	1.2-17	5 / 14	2.87E+00	5.20E+00	5.87E+00
Toluene	0.0012-4.9	5 / 16	6.18E-01	1.60E+00	1.47E+00
Xylene	0.0053-1.8	5 / 16	2.30E-01	5.76E-01	5.36E-01

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 7.7
SITE 3/6, FUEL SPILL AREA
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 3/6; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Low concentrations of VOCs were detected in soils. Site is fenced and much of the surface is covered with concrete. Employees only come onsite to refuel vehicles.
	Contaminated surface soils/ fugitive dust generation	Site 3/6; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Site is fenced and much of the surface is covered with concrete. Employees only come onsite to refuel vehicles. Lead was detected in surface soils but at a concentration well below EPA's risk-based clean up target of 500 ppm.
Groundwater	Contaminated soils/leaching to groundwater	Site 3/6; Downgradient wells	Nearby residents, onsite workers	Oral, dermal, inhalation	None. Groundwater contamination is present but has not been detected at a current exposure point.
Surface Water	Contaminated soils and groundwater/ surface runoff, groundwater seepage	Lemonwier River	Onsite workers, nearby residents	Oral, dermal, inhalation	None. There is no surface water on site. The river is over 2 miles away.
Soils	Contaminated soils/ leaching, runoff, tracking	Site 3/6	Onsite workers	Oral, dermal	Very low. Site is fenced and much of the surface is covered with concrete. Employees only come onsite to refuel vehicles.

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TABLE 7.7–Continued
SITE 3/6, FUEL SPILL AREA
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS					
Air	Contaminated soils/volatilization, fugitive dust generation	Site 3/6; areas downwind	Future residents, onsite workers	Inhalation	Very low. Less than for current scenario because of degradation of organic contaminants.
Groundwater	Contaminated soils/leaching	Wells onsite and downgradient.	Future residents, onsite workers	Oral, dermal, inhalation	Low to moderate. Groundwater contamination is present and if an onsite drinking water well were installed exposure would occur.
Surface Water	Contaminated soil/ surface runoff, groundwater seepage	Lemonwier River	Future residents	Oral, dermal, inhalation	Unlikely. There is no surface water on site. The river is over 2 miles away.
Soils	Contaminated soils, groundwater/ leaching, runoff, tracking	Site 3/6	Future residents, onsite workers	Oral, dermal	Low to moderate. Contamination was detected in soils and onsite residents would be particularly susceptible to exposure.

TABLE 7.8
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	1.10E-06	1.21E-05	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.9
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	1.28E-05	1.41E-04	ND	NA
Petroleum Hydrocarbons	2.51E+04	1.28E-05	3.22E-01	ND	NA
Toluene	9.07E-03	1.28E-05	1.16E-07	2.00E-01	5.80E-07
				HAZARD INDEX =	6E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND – Not Determined
NA – Not Applicable

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TABLE 7.10
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	3.49E-07	3.84E-06	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.11
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	9.78E-07	1.08E-05	ND	NA
Petroleum Hydrocarbons	2.51E+04	9.78E-07	2.46E-02	ND	NA
Toluene	9.07E-03	9.78E-07	8.87E-09	2.00E-01	4.43E-08
				HAZARD INDEX =	4E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 7.12
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	5.87E-07	6.46E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.13
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY ADULTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	1.37E-06	1.51E-05	ND	NA
Petroleum Hydrocarbons	2.51E+04	1.37E-06	3.44E-02	ND	NA
Toluene	9.07E-03	1.37E-06	1.24E-08	2.00E-01	6.21E-08
				HAZARD INDEX =	6E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.14
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.15
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	2.51E+04	1.86E-05	4.67E-01	ND	NA
Toluene	9.07E-03	1.86E-05	1.69E-07	2.00E-01	8.43E-07
				HAZARD INDEX =	8E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

TABLE 7.16
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.17
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	2.51E+04	6.64E-06	1.67E-01	ND	NA
Toluene	9.07E-03	6.64E-06	6.02E-08	2.00E-01	3.01E-07
				HAZARD INDEX =	3E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.18
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.10E+01	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.19
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.10E+01	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	2.51E+04	2.20E-06	5.53E-02	ND	NA
Toluene	9.07E-03	2.20E-06	1.99E-08	2.00E-01	9.97E-08
				HAZARD INDEX =	1E-07

(a) *Based on compounds detected in top 2 feet of soil.*
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.20
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	1.10E-06	4.53E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.21
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	1.28E-05	1.65E-05	1.00E-01	1.65E-04
Lead	4.12E+00	1.28E-05	5.27E-05	ND	NA
Petroleum Hydrocarbons	1.57E+03	1.28E-05	2.01E-02	ND	NA
Toluene	1.67E+01	1.28E-05	2.14E-04	2.00E-01	1.07E-03
Xylene	2.75E+01	1.28E-05	3.52E-04	2.00E+00	1.76E-04
				HAZARD INDEX =	1E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.22
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	3.49E-07	1.44E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.23
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	9.78E-07	1.26E-06	1.00E-01	1.26E-05
Lead	4.12E+00	9.78E-07	4.03E-06	ND	NA
Petroleum Hydrocarbons	1.57E+03	9.78E-07	1.54E-03	ND	NA
Toluene	1.67E+01	9.78E-07	1.63E-05	2.00E-01	8.17E-05
Xylene	2.75E+01	9.78E-07	2.69E-05	2.00E+00	1.35E-05
				HAZARD INDEX =	1E-04

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 7.24
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	5.87E-07	2.42E-06	ND	NA
			CARCINOGENIC RISK =		0.00E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.25
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	1.37E-06	1.77E-06	1.00E-01	1.77E-05
Lead	4.12E+00	1.37E-06	5.64E-06	ND	NA
Petroleum Hydrocarbons	1.57E+03	1.37E-06	2.15E-03	ND	NA
Toluene	1.67E+01	1.37E-06	2.29E-05	2.00E-01	1.14E-04
Xylene	2.75E+01	1.37E-06	3.77E-05	2.00E+00	1.89E-05
				HAZARD INDEX =	2E-04

(a) Based on compounds detected deeper than 2 feet.

(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean

(c) Intake variables are not adjusted for absorption.

ND - Not Determined

NA - Not Applicable

TABLE 7.26
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0.00E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.27
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	1.86E-05	2.40E-05	1.00E-01	2.40E-04
Lead	4.12E+00	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.57E+03	1.86E-05	2.92E-02	ND	NA
Toluene	1.67E+01	1.86E-05	3.11E-04	2.00E-01	1.55E-03
Xylene	2.75E+01	1.86E-05	5.12E-04	2.00E+00	2.56E-04
				HAZARD INDEX =	2E-03

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

TABLE 7.28
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0.00E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.29
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	6.64E-06	8.56E-06	1.00E-01	8.56E-05
Lead	4.12E+00	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.57E+03	6.64E-06	1.04E-02	ND	NA
Toluene	1.67E+01	6.64E-06	1.11E-04	2.00E-01	5.55E-04
Xylene	2.75E+01	6.64E-06	1.83E-04	2.00E+00	9.14E-05
				HAZARD INDEX =	7E-04

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.30
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	4.12E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0.00E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.31
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Ethylbenzene	1.29E+00	2.20E-06	2.84E-06	1.00E-01	2.84E-05
Lead	4.12E+00	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.57E+03	2.20E-06	3.46E-03	ND	NA
Toluene	1.67E+01	2.20E-06	3.68E-05	2.00E-01	1.84E-04
Xylene	2.75E+01	2.20E-06	6.06E-05	2.00E+00	3.03E-05
				HAZARD INDEX =	2E-04

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 7.32
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	6.14E-01	1.10E-02	6.76E-03	2.90E-02	1.96E-04
			CARCINOGENIC RISK =		2E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.

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TABLE 7.33
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	6.14E-01	1.28E-01	7.86E-02	ND	NA
Ethylbenzene	8.83E-02	1.28E-01	1.13E-02	1.00E-01	1.13E-01
Petroleum Hydrocarbons	5.87E+00	1.28E-01	7.52E-01	ND	NA
Toluene	1.47E+00	1.28E-01	1.88E-01	2.00E-01	9.41E-01
Xylene	5.36E-01	1.28E-01	6.87E-02	2.00E+00	3.43E-02
				HAZARD INDEX =	1E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.34
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	6.14E-01	3.49E-03	2.14E-03	2.90E-02	6.22E-05
			CARCINOGENIC RISK =		6E-05

(a) *Based on concentrations in onsite, downgradient wells.*
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.

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TABLE 7.35
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	6.14E-01	9.78E-03	6.01E-03	ND	NA
Ethylbenzene	8.83E-02	9.78E-03	8.64E-04	1.00E-01	8.64E-03
Petroleum Hydrocarbons	5.87E+00	9.78E-03	5.75E-02	ND	NA
Toluene	1.47E+00	9.78E-03	1.44E-02	2.00E-01	7.19E-02
Xylene	5.36E-01	9.78E-03	5.25E-03	2.00E+00	2.62E-03
				HAZARD INDEX =	8E-02

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 7.36
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	6.14E-01	1.17E-02	7.19E-03	2.90E-02	2.08E-04
				CARCINOGENIC RISK =	2E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.

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TABLE 7.37
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	6.14E-01	2.74E-02	1.68E-02	ND	NA
Ethylbenzene	8.83E-02	2.74E-02	2.42E-03	1.00E-01	2.42E-02
Petroleum Hydrocarbons	5.87E+00	2.74E-02	1.61E-01	ND	NA
Toluene	1.47E+00	2.74E-02	4.03E-02	2.00E-01	2.01E-01
Xylene	5.36E-01	2.74E-02	1.47E-02	2.00E+00	7.35E-03
				HAZARD INDEX =	2E-01

(a) Based on concentrations in onsite, downgradient wells.

(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.

(c) Intake variables are not adjusted for absorption.

ND - Not Determined

NA - Not Applicable

TABLE 7.38
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	6.14E-01	6.70E-06	4.12E-06	2.90E-02	1.19E-07
			CARCINOGENIC RISK =		1E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.

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TABLE 7.39
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	6.14E-01	7.82E-05	4.80E-05	ND	NA
Ethylbenzene	8.83E-02	7.82E-05	6.90E-06	1.00E-01	6.90E-05
Petroleum Hydrocarbons	5.87E+00	7.82E-05	4.59E-04	ND	NA
Toluene	1.47E+00	7.82E-05	1.15E-04	2.00E-01	5.75E-04
Xylene	5.36E-01	7.82E-05	4.19E-05	2.00E+00	2.10E-05
				HAZARD INDEX =	7E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.40
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	6.14E-01	1.91E-05	1.17E-05	2.90E-02	3.40E-07
			CARCINOGENIC RISK =		3E-07

(a) Based on concentrations in *onsite, downgradient* wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.

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TABLE 7.41
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	6.14E-01	4.46E-05	2.74E-05	ND	NA
Ethylbenzene	8.83E-02	4.46E-05	3.94E-06	1.00E-01	3.94E-05
Petroleum Hydrocarbons	5.87E+00	4.46E-05	2.62E-04	ND	NA
Toluene	1.47E+00	4.46E-05	6.56E-05	2.00E-01	3.28E-04
Xylene	5.36E-01	4.46E-05	2.39E-05	2.00E+00	1.20E-05
				HAZARD INDEX =	4E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 7.42
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	6.14E-01	5.43E-03	3.90E+01	8.3E-06	3.2E-04
				CARCINOGENIC RISK =	3E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 7.43
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	6.14E-01	5.43E-03	4.55E-01	ND	NA
Ethylbenzene	8.83E-02	8.44E-03	1.02E-01	1.0E+00	1.02E-01
Toluene	1.47E+00	5.94E-03	1.19E+00	2.0E+00	5.96E-01
Xylene	5.36E-01	5.10E-03	3.73E-01	3.0E-01	1.24E+00
			HAZARD INDEX =		2E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 7.44
SITE 3/6, FUEL SPILL SITE
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	6.14E-01	5.43E-03	1.95E+02	8.3E-06	1.6E-03
				CARCINOGENIC RISK =	2E-03

(a) Based on *concentrations in onsite*, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 7.45
SITE 3/6, FUEL SPILL SITE
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	6.14E-01	5.43E-03	4.55E-01	ND	NA
Ethylbenzene	8.83E-02	8.44E-03	1.02E-01	1.0E+00	1.02E-01
Toluene	1.47E+00	5.94E-03	1.19E+00	2.0E+00	5.96E-01
Xylene	5.36E-01	5.10E-03	3.73E-01	3.0E-01	1.24E+00
			HAZARD INDEX =		2E+00

(a) Based on concentrations in onsite, downgradient wells.

(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.

(c) Derived from groundwater concentration via shower model presented in Section 4.

ND - Not Determined

NA - Not Applicable

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TABLE 7.46
SITE 3/6, FUEL SPILL SITE
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Pathway Risk	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	NQ (a)	
	Dermal Absorption from Surface Soils	NQ (a)	
Future Onsite Workers	Incidental Ingestion of Deep Soils	NQ (a)	
	Dermal Absorption from Deep Soils	NQ (a)	
	Incidental Ingestion of Surface Soils	NQ (a)	
	Dermal Absorption from Surface Soils	NQ (a)	
	Ingestion of Groundwater	6E-05	Benzene
Future Adult Residents	Incidental Ingestion of Deep Soils	NQ (a)	
	Dermal Absorption from Deep Soils	NQ (a)	
	Ingestion of Groundwater	2E-04	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	2E-03	Benzene
	Dermal Absorption from Groundwater	3E-07	Benzene
	Incidental Ingestion of Surface Soils	NQ (a)	
	Dermal Absorption from Surface Soils	NQ (a)	
Future Children	Incidental Ingestion of Deep Soils	NQ (a)	
	Dermal Absorption from Deep soils	NQ (a)	
	Ingestion of Groundwater	2E-04	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	3E-04	Benzene
	Dermal Absorption from Groundwater	1E-07	Benzene
	Incidental Ingestion of Surface Soils	NQ (a)	
	Dermal Absorption from Surface Soils	NQ (a)	

(a) Not Quantifiable; there is no oral slope factor for lead.

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TABLE 7.47
SITE 3/6, FUEL SPILL SITE
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	4E-08	Toluene
	Dermal Absorption from Surface Soils	3E-07	Toluene
Future Onsite Workers	Incidental Ingestion of Deep Soils	1E-04	Toluene
	Dermal Absorption from Deep Soils	7E-04	Toluene
	Incidental Ingestion of Surface Soils	4E-08	Toluene
	Dermal Absorption from Surface Soils	3E-07	Toluene
	Ingestion of Groundwater	8E-02	Toluene
Future Adult Residents	Incidental Ingestion of Deep Soils	2E-04	Toluene
	Dermal Absorption from Deep Soils	2E-04	Toluene
	Ingestion of Groundwater	2E-01	Toluene
	Inhalation of VOCs Released from Groundwater during Showering	2E+00	Xylene
	Dermal Absorption from Groundwater	4E-04	Toluene
	Incidental Ingestion of Surface Soils	6E-08	Toluene
	Dermal Absorption from Surface Soils	1E-07	Toluene
Future Child Residents	Incidental Ingestion of Deep Soils	1E-03	Toluene
	Dermal Absorption from Deep Soils	2E-03	Toluene
	Ingestion of Groundwater	1E+00	Toluene
	Inhalation of VOCs Released from Groundwater during Showering	2E+00	Xylene
	Dermal Absorption from Groundwater	7E-04	Toluene
	Incidental Ingestion of Surface Soils	6E-07	Toluene
	Dermal Absorption from Surface Soils	8E-07	Toluene

TABLE 7.48
CHEMICAL CONSTITUENTS DETECTED AT SITE 3/6 AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Ethylbenzene	1988, 1990	8.9	--	--	--
Lead	1988, 1990	14	--	--	--
Toluene	1990	73	--	--	--
TPH	1988, 1990	36,000	--	--	--
Xylenes	1988, 1990	130	--	--	--
Groundwater (ug/L)					
Benzene	1988, 1989, 1990	2,200	MCL/WIDNR	5	Yes
Ethylbenzene	1989, 1990	260	MCL	700	No
Lead	1988, 1989	11	MCL	15	No
TDS	1989, 1990	330,000	--	--	--
Toluene	1988, 1989, 1990	4,900	WIDNR	343	Yes
TPH	1989, 1990	17,000	--	--	--
Xylenes	1988, 1989, 1990	1,800	WIDNR	620	Yes

MCL - Safe Drinking Water Act Maximum Contaminant Level.

WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.

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SECTION 8
SITE 4 - TRANSFORMER FLUID DISPOSAL AREA

BACKGROUND

Site 4 is located under the asphalt parking lot approximately 100 feet south of Building 331 (Figure 8.1). Fluid from approximately 10 transformers was emptied onto the ground in this area in 1967 or 1968. Although the material discarded at this site was never analyzed, transformers from this time period often contained PCBs. The disposal area was paved in 1977, resulting in a period of approximately 10 years during which migration of contaminants may have occurred.

1987 Field Activities

During the 1987 SI, eight soil borings (SB-1 through SB-8 on Figure 8.1) were augered to obtain lithological information and soil samples for chemical analysis. Groundwater was not encountered in any of the borings. No PCBs were found above detection limits in the samples analyzed [ES, 1990c].

1989 Field Activities

Three soil borings (SB-9 through SB-11 on Figure 8.1) were advanced to a depth of 10 feet. Soil samples were collected from these borings and analyzed for PCBs and total oil and grease. After sampling was completed, the borings were surveyed.

1990 and 1991 Field Activities

Since no evidence of contamination was found in the previous investigations at this site, no additional fieldwork was required in 1990 or 1991.

RESULTS

Test borings indicate Site 4 is underlain by mostly fine, silty, yellowish brown sand. Weathered, Cambrian sandstone underlying the sand was encountered at a depth of about 10 feet. Groundwater was not encountered in any of the soil borings. Soil boring logs are included in Appendix B.

Data collected for Site 4 include soil samples which were taken at depths ranging from 0 to 8.5 feet. A total of 18 samples were taken from eight locations during December 1987 and January 1988. A total of seven samples were taken from three additional locations in November 1989 (Table 8.1). Samples taken during the first round of sampling in 1987 were analyzed for PCBs by method SW8080. No

PCBs were detected in any sample. Samples taken during the second round of sampling were analyzed for organochlorine pesticides and PCBs (CLP-SOW) and for oil and grease (SW9071). No PCBs, oil and grease, or pesticides were detected in any sample, although the data for aldrin are questionable due to retention times being slightly off during laboratory analysis. Sample quantitation limits for PCBs and toxaphene ranged from 0.0832 to 0.2208 mg/kg. Sample quantitation limits ranged from 0.0832 to 0.1104 mg/kg for methoxychlor, and from 0.0083 to 0.0276 mg/kg for the remaining pesticides. The quantitation limit for oil and grease was 10 mg/kg.

BASELINE RISK ASSESSMENT

The following subsections present the Site 4 baseline risk assessment including a human health and ecological evaluation.

Human Health Evaluation

All of the available analytical data were reviewed in light of the analytical methods used, quantitation limits, data qualifiers and QA/QC samples. A summary of the exposure assessment follows.

Since no PCBs were detected in soils at Site 4, there are no complete current or hypothetical (future) exposure pathways. Groundwater immediately downgradient of Site 4 was not tested for PCBs, since no source of PCBs was detected in the soils at Site 4. PCBs are generally immobile in soils and do not migrate readily to groundwater. PCB movement from soil into groundwater is influenced by factors such as soil permeability, organic carbon content, and the presence of organic colloids which could facilitate transport. Solubilities range from 1.2E-02 to 2.7E-03 mg/L of water for the PCBs which have been associated with toxicity (PCB-1248, PCB-1254 and PCB-1260).

Quantifiable human health risks are not associated with past waste disposal activities at this site because chemical contaminants were not detected.

Ecological Evaluation

Site 4 is covered with grass and concrete. A stand of northern hardwoods and jack pines is directly north of the site. Stands of oak, northern hardwoods, and aspen occur to the northeast of the site next to Site 7. Cover types consisting of northern hardwood, red pine, mixed conifer, marsh, grassland, lowland brush, white pine and bottomland hardwoods occur on the Base south of Site 4. Ecological receptors supported by these habitats are summarized in Section 4.

Since contaminants were not detected at this site, exposure pathways are not considered complete, and there are no risks for ecological receptors.

CONCLUSIONS AND RECOMMENDATIONS

Based on site history, PCBs were the contaminants expected at this site. PCBs were not detected in soil samples collected from 11 soil borings installed at this site, therefore, no human health or ecological risks are associated with Site 4. A No-Further-Action Decision Document should be prepared and submitted to the WIDNR.

Figure 8.1

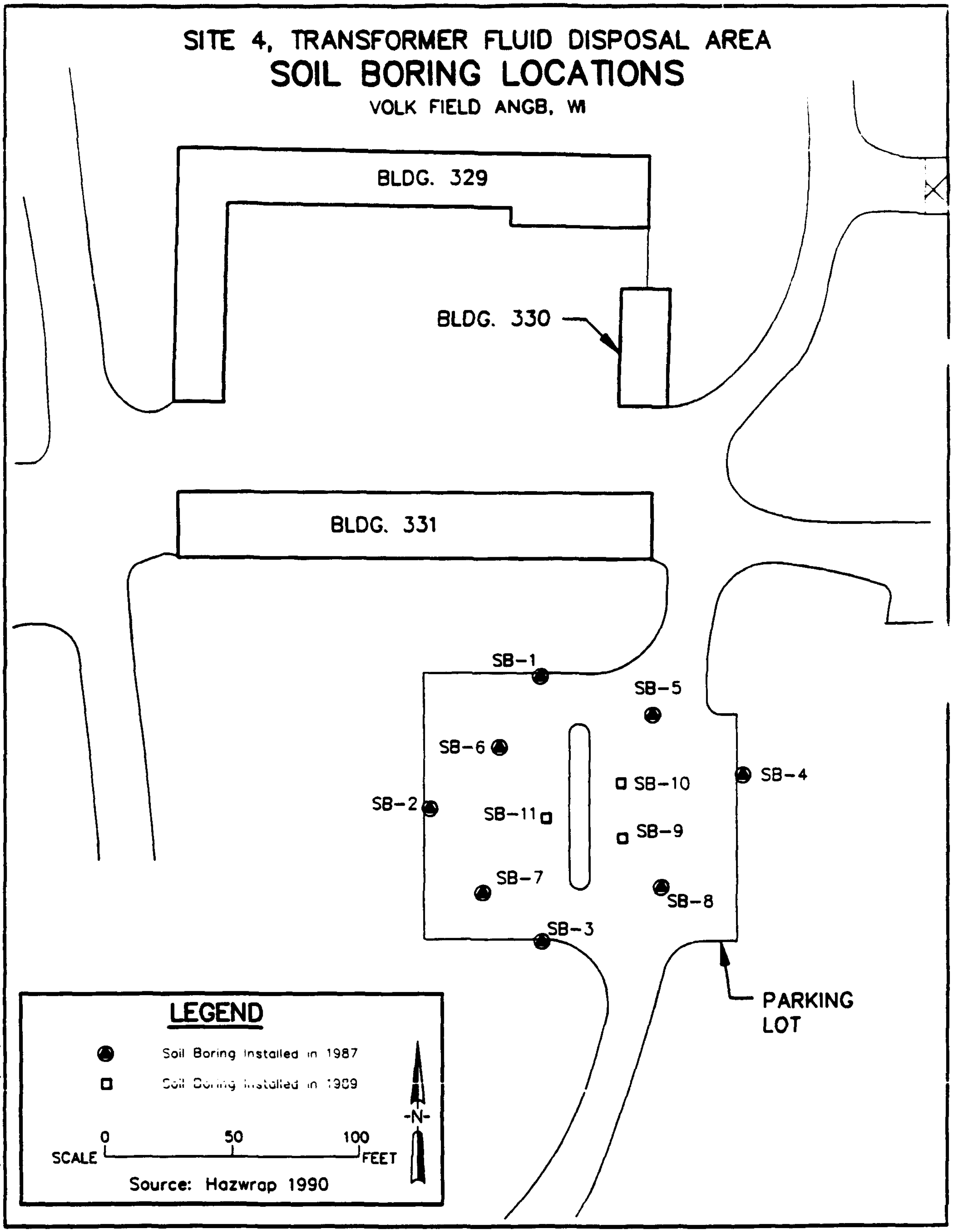

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TABLE 8.1
SITE 4, TRANSFORMER FLUID DISPOSAL AREA
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF4 SB9 SS1 (3.5–5.5)	VF4 SB9 SS2 (8.5–10.5)	VF4 SB10 SS1 (1.0–3.0)	VF4 SB10 SS2 (8.0–10.0)	VF4 SB11 SS1 (1.0–3.0)	VF4 SB11 SS2 (8.5–10.5)	VF4 SB13 SS1* (1.0–3.0)
Date Sampled	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89	11/02/89
Oil & Grease (9071) (mg/kg)	U	U	U	U	U	U	U
Organochlorine Pesticides & PCB's CLP SOW (ug/kg)	ND	ND	ND	ND	ND	ND	ND

ND – No analytes detected for this method.
U – Below the detection limit.
* VF4 SB13 SS1 is a duplicate of VF4 SB10 SS1.

SECTION 9
SITE 5 - KC97 CRASH SITE

BACKGROUND

This subsection provides a site description and summary of the investigations conducted at Site 5-KC97 Crash Site.

Site Description and History

Site 5 is located approximately 400 feet north of Taxiway 3 and parallel to the main runway (Figure 9.1). The site is approximately 400 feet long, east to west, and 150 feet wide, north to south. A low-lying area is present in the central and western sections of the site. An estimated 2,000 to 5,000 gallons of JP-4 and AVGAS were released in this area in 1978 as a result of a KC97 refueler aircraft accident. Approximately 50 percent of the spilled fuel was consumed by fire and the remainder evaporated or seeped into the ground [HMTC, 1984].

This site was not investigated during the 1987 field investigation.

1989 Field Activities

The 1989 field program included a soil gas survey, soil borings, monitoring well installation, and soil and groundwater sampling for chemical analysis.

The soil gas survey consisted of a total of 93 soil gas points. Ninety-two of these points were installed to a depth of 4 to 5 feet on a grid of 25-foot centers (Figure 9.2). The remaining soil gas point was installed at 7.5 feet at a location where a vertical profile was obtained. The soil gas results identified an area in the southeastern corner of the site where the soil contained volatile organics. The soil gas data were used to select soil boring and monitoring well locations.

Ten soil borings were advanced to a depth of 6 feet and one boring was advanced to 8.5 feet (Figure 9.1). Sixteen soil samples were collected and analyzed for halogenated and aromatic volatile organics, lead, and TPH.

One monitoring well (Figure 9.1) was installed at Site 5 to determine if groundwater contamination is present. The well (MW-1) was located near soil boring SB-1, in the area of greatest soil contamination. This well was screened from 6 to 21 feet. A groundwater sample was obtained and analyzed for halogenated and aromatic volatile organics, TPH, lead, TDS, and field parameters (pH, specific conductance and temperature).

1990 Field Activities

The monitoring well, MW-1, was sampled and analyzed for the same parameters as in 1989. Groundwater measurements were taken at the beginning and at the end of the 1990 field investigation.

1991 Field Activities

The groundwater elevation at VF5 MW-1 was measured on 30 October 1991.

RESULTS

The results of the hydrogeologic investigation, soil gas survey, and soil and water sampling efforts are provided in this subsection.

Geology/Hydrogeology

Soils encountered at this site are predominantly silty, clayey sands of Pleistocene age which range in color from very pale orange to black. Sandstone was not encountered at this site.

The groundwater elevation in MW-1 measured on 13 November 1990 is 898.32 feet above MSL (Table 2.4 of the Environmental Setting). The depth to groundwater is approximately 3.5 feet BLS. Groundwater flow at this site is toward the northeast indicated on Figure 9.1. Soil boring logs, the well construction logs and a summary of groundwater measurements presented in Appendix B.

Soil Gas Survey Results

This subsection presents a summary of the results of the soil gas survey. A complete description of the soil gas survey is included in Appendix D.

The site of the spill was identified by a soil gas survey conducted over approximately 6,000 square feet. Seven soil gas samples contained total hydrocarbons in excess of 1,000 ppb (Figure 9.2). TCE and 1,1-dichloroethene were tentatively identified in six of the samples collected at this site; however, there is considerable uncertainty in identifying chlorinated compounds in the presence of high concentrations of petroleum products.

o-Xylene was detected at 25 soil gas points (Figure 9.3) and toluene was detected in 22 samples (Figure 9.4).

Many soil gas points had small ill-defined chromatograph peaks. The peaks were not produced by any of the six calibrated standards. The small peaks may have resulted from column contamination, low concentrations of other xylene isomers, naturally occurring compounds in peat bogs, or low concentrations of uncalibrated fuel constituents.

Soil Sampling Results

Soil samples were collected from 11 borings which were located to define the magnitude and extent of contamination in the unsaturated soils. The location of these soil borings is indicated on Figure 9.5. All samples were analyzed for halogenated volatiles, aromatic volatiles, TPH and lead. Halogenated volatiles were analyzed to confirm or deny the presence of TCE which was tentatively identified during the soil gas survey. No TCE was found in the soil samples.

The sample obtained from boring SB-2 at 3.5 to 5.5 feet contained toluene at 1.9 mg/kg and xylene at 2.1 mg/kg. These are the maximum toluene and xylene concentrations detected in the soil samples collected at this site. These concentrations are below proposed soil criteria. The sample collected from the same soil boring at 0 to 2 feet did not contain aromatic volatiles. At 5.5 to 8.0 feet, toluene was detected at 0.012 mg/kg. Samples collected from borings other than SB-2 contained toluene and/or xylenes at concentrations ranging from ND to 0.036 mg/kg. A summary of the soil sampling results is presented in Table 9.1.

Total petroleum hydrocarbons were detected in twelve soil samples at levels ranging from 16 mg/kg to 58 mg/kg. The highest value was collected from boring SB-1.

Concentrations of lead in soil samples ranged from 0.95 mg/kg to 100 mg/kg. Lead concentrations in a majority of the samples was below 7 mg/kg. The highest concentration of lead, 100 mg/kg at boring SB-1, may be a remnant of AVGAS released at this site. However, the areal extent of this contaminant appears to be limited to a very small area. Table 4.5 of the Criteria for Evaluating Results section presents the concentrations of lead detected in background locations at the Base.

Groundwater Analytical Results

A groundwater sample was collected from MW-1 (Figure 9.1) in both 1989 and 1990. TDS was found ranging from 130 mg/L to 160 mg/L. Other analytes were not detected. A summary of this information is provided in Tables 9.2 and 9.3.

BASELINE RISK ASSESSMENT

The following subsections present the Site 5 risk assessment. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the risk assessment. Analytical results for soil and groundwater samples from 1989 and 1990 were used in the preparation of this risk assessment. The risk assessment presented here was conducted according to the most recent EPA guidelines and considers all of the available site monitoring data through 1991.

Selection of Chemicals of Concern

Aromatic volatile organics, lead and TPH were detected in soil and groundwater samples associated with Site 5. Based on the chemicals detected in

1989 and 1990 rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected for each medium. The available toxicity information for the chemicals detected at this site is discussed in Section 4 and Appendix F.

Soils

Toluene, xylene, lead, and TPH were retained as chemicals of concern for soils at Site 5. The arithmetic average, standard deviation, and the maximum detected concentrations or 95 percent UCL of the arithmetic average (mean) for each of these chemicals are presented for surface soils and deeper soils in Tables 9.4 and 9.5, respectively.

Groundwater

No contaminants were detected in two groundwater samples taken from the one monitoring well; therefore, no chemicals of concern were selected for groundwater.

Human Health Evaluation

The following subsections present the Site 5 human health evaluation.

Exposure Pathways

Potential sources for contaminant release at this site include the fuels spilled at the site and any soils in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 5 are soils at the site (both on the surface and at depth). Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point.

Site 5 is immediately north of the main runway. Access is restricted to an occasional Base worker who mows the grass along the runway. Site 5 is heavily vegetated.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 5 are summarized in Table 9.6.

Soils. Current pathways involving incidental ingestion of and dermal contact with soils at Site 5 are unlikely but possible for onsite workers. In the unlikely event that the runway were closed and a residence were constructed at the site, both oral and dermal contact with soils by hypothetical residents would be more likely to occur. Hypothetical (future) workers could also be exposed to site soils.

Groundwater. There are private water supply wells downgradient of the site. However, no contaminants were detected in the groundwater at Site 5, and groundwater contamination in onsite or downgradient drinking water wells (now or in the future) is not likely.

Surface Water. Site 5 lies in a boggy area within the Lemonwier River drainage basin. However, since the river is more than 2 miles away from the site, contamination in surface runoff from the site is not likely to reach the river in detectable concentrations. Migration of contaminants from the site via groundwater discharge is possible, but no contaminants were present in the site groundwater and groundwater discharge could not contribute detectable contamination to the river. Therefore, surface water pathways at Site 5 are not considered further.

Air. Since VOCs were detected in soil samples taken from Site 5, it is possible that exposure could occur via inhalation of these compounds released to air. Current exposures would be primarily restricted to workers who mow the grass along the runway and to residents in areas downwind of the site. Given the low concentration of VOCs present in soils, the concentrations released to air are low, particularly for residents and workers who do not remain on the site. The worst-case exposure scenario would be for a hypothetical future resident who might build a house directly on top of the site.

Similarly, exposures via inhalation of lead released to air via wind erosion of the surface soils could occur. However, given the heavy vegetative cover at the site, the release of contaminants to air via wind erosion is extremely unlikely. If someone were to construct a house on site, exposure via airborne contaminants released from both surface soils and exposed deeper soils could occur.

Exposure to contaminants released to air from soils was not quantified since the risks associated with these pathways would be orders of magnitude lower than those associated with oral and dermal pathways. Low risks are anticipated for air pathways because of the low concentrations of contaminants in soils. Releases to air by volatilization or wind erosion would be mitigated by dispersion and degradative processes. The VOCs detected in soils which would drive the risks associated with air exposure (toluene, xylenes) have short half-lives in air ranging from 2.6 hours to 1.8 days (xylene) tc 10 hours to 4.3 days (toluene) [Howard et al., 1991]. Furthermore, releases of lead through wind erosion would be controlled by the vegetative cover present at the site.

In this assessment, exposure concentrations, exposure intakes (oral and dermal pathways only), and subsequent risks and hazard indices were calculated for the following pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of surface soils	Children	9.7	9.8
	Workers	9.9	9.10
	Adult residents	9.11	9.12
Dermal contact with surface soils	Children	9.13	9.14
	Workers	9.15	9.16
	Adult residents	9.17	9.18
Ingestion of deeper soils	Children	9.19	9.20
	Workers	9.21	9.22
	Adult residents	9.23	9.24
Dermal contact with deeper soils	Children	9.25	9.26
	Workers	9.27	9.28
	Adult residents	9.29	9.30

Risk Characterization

Carcinogenic Risks

Carcinogenic risks for all soil pathways and receptors do not exceed EPA's target risk range of one-in-one-million (1E-06) to one-in-ten-thousand (1E-04) (Table 9.31). However, lead was the only carcinogenic compound detected in soils, and carcinogenic risks associated with exposure to lead cannot be calculated since there is no slope factor for lead. However, since the lead concentrations detected in soils (0.95 to 100 mg/kg) were well below EPA's risk-based target concentration for lead in soil (500 mg/kg), risks associated with ingestion, dermal contact with or inhalation of lead are likely to be well below EPA's target risk range.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 9.32. A hazard index which exceeds 1 is an indication that adverse health effects are likely.

The hazard indices for all soil exposure pathways and receptors were much less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e, residential use of the site), the calculated hazard indices for soil pathways at Site 5 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Ecological Evaluation

Site 5 is located in a marshy area. Ecological receptors supported by this habitat are summarized in Section 4. In addition to these receptors, Blanchard's cricket frog (*Acris crepitans blanchardi*), which is an endangered resource in the State of Wisconsin, is found in this area.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 5 could include the following:

- Ingestion and dermal contact with contaminants in soils, particularly for burrowing species of animals;
- Uptake of contaminants in soils by plants; and
- Inhalation of VOCs released from contaminated soils by terrestrial and avian species.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is vegetated. Inhalation exposures resulting from VOCs released from soils are unlikely to be significant due to the low concentrations detected and limited source area. Oral and dermal exposures for animals and uptake by plants are similarly expected to be limited.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in soils. However, toxicity values are available to evaluate compounds detected in soils associated with Site 5 and are presented in Table 4.10. These values include acute oral LD50s for mammals. It should be noted that these values can be used only in a qualitative way to screen for potential impacts. Acute LD50 values can only be used to highlight which of the detected chemicals might be toxic to mammals. There are no similar criteria for plants or birds.

Risk Characterization

A method of screening the relative toxicity of a chemical detected in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils. Lead is the only compound detected in soils which is severely toxic to mammals. The toluene and xylenes detected in soils at Site 5 are classified as slightly toxic with respect to acute oral toxicity. Lead can also be toxic to plants when present in acidic soil. The effects of TPH, if any, are unknown.

Risk Assessment Conclusions

This subsection presents the conclusions and uncertainties of the baseline risk assessment.

Human Receptors

Toluene, xylene, lead, and TPH were detected in soils at Site 5. No groundwater contamination was detected. Due to the proximity of the site to the main runway, the low level of contamination detected and the thick vegetative cover at the site, current human exposure at Site 5 is unlikely. The only current exposure pathways which could possibly occur are incidental ingestion of and dermal contact

with surface soils by Base workers during runway maintenance. Hypothetical (future) ingestion of and dermal contact with contaminants in both surface and deep soils are possible if someone were to build a house at the site. Hypothetical (future) workers could also ingest and have dermal contact with contaminants in surface and deep soils. Inhalation pathways associated with VOCs and lead in surface soils are possible but were not calculated since risks associated with these pathways are likely to be orders of magnitude lower than those associated with the oral and dermal pathways. No adverse noncarcinogenic risks are expected to occur in association with Site 5. Carcinogenic risks associated with potential exposures to lead in soils are well below EPA's established soil concentration (500 mg/kg) which is based on uptake and blood lead levels.

Potential risks associated with TPH in soils were also not quantified in this assessment due to the lack of reference toxicity values. A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4. No further uncertainties apply to this assessment.

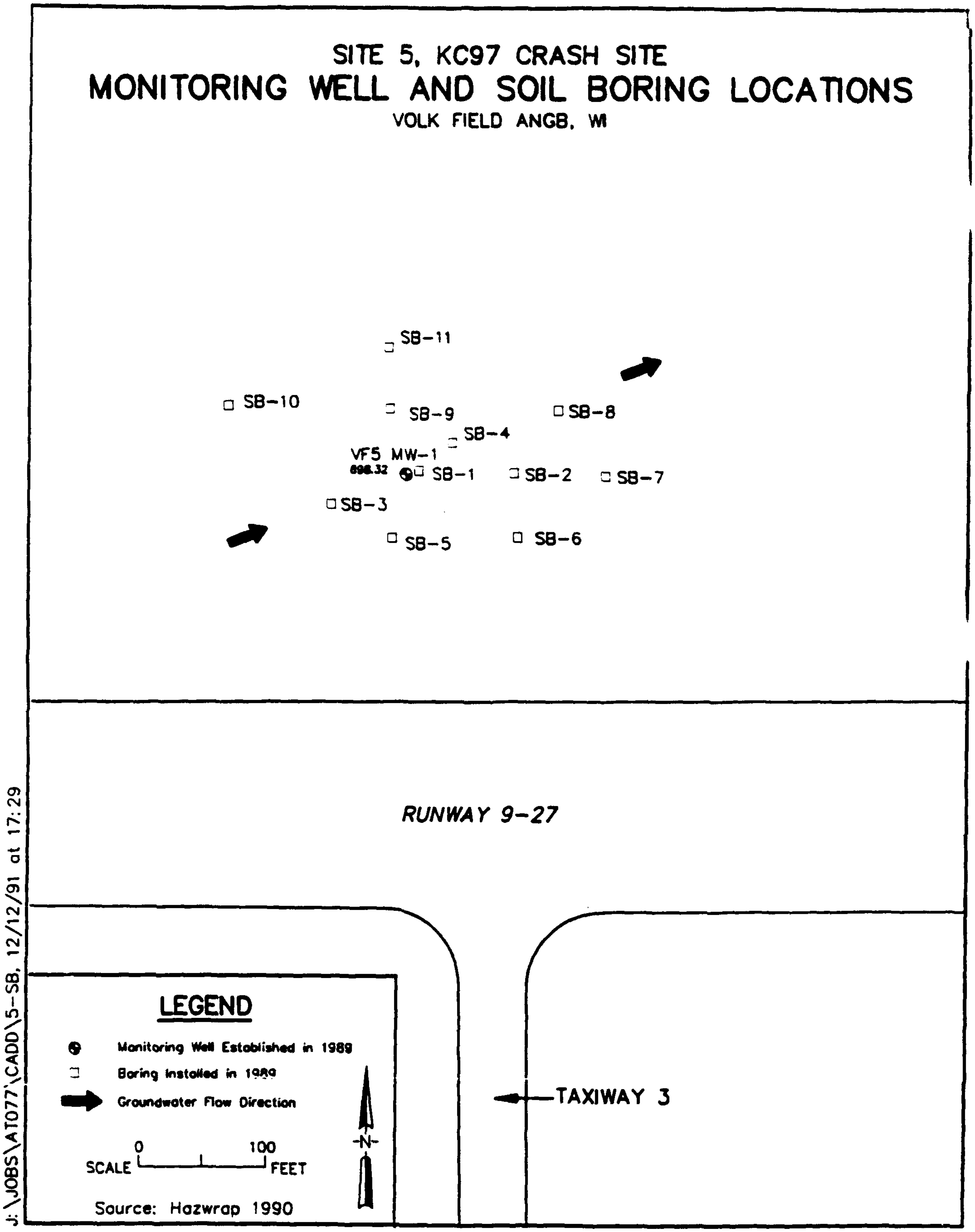
Ecological Receptors

Flora and fauna could be exposed through uptake of chemicals detected in soils. Burrowing animals are of particular concern, but exposures are expected to be limited.

It is not possible to characterize the ecological risks associated with contaminants detected at Site 5 due to the lack of approved reference toxicity information. However, toxicity values are available to qualitatively evaluate compounds detected in soils. Based on reference values for acute exposure, lead is the only compound in soils which is severely toxic to mammals. However, available ecological databases are not sufficiently comprehensive to predict whether the concentrations detected in soils will result in adverse ecological effects. Since no groundwater contamination was detected, exposures via groundwater (plants) are not expected.

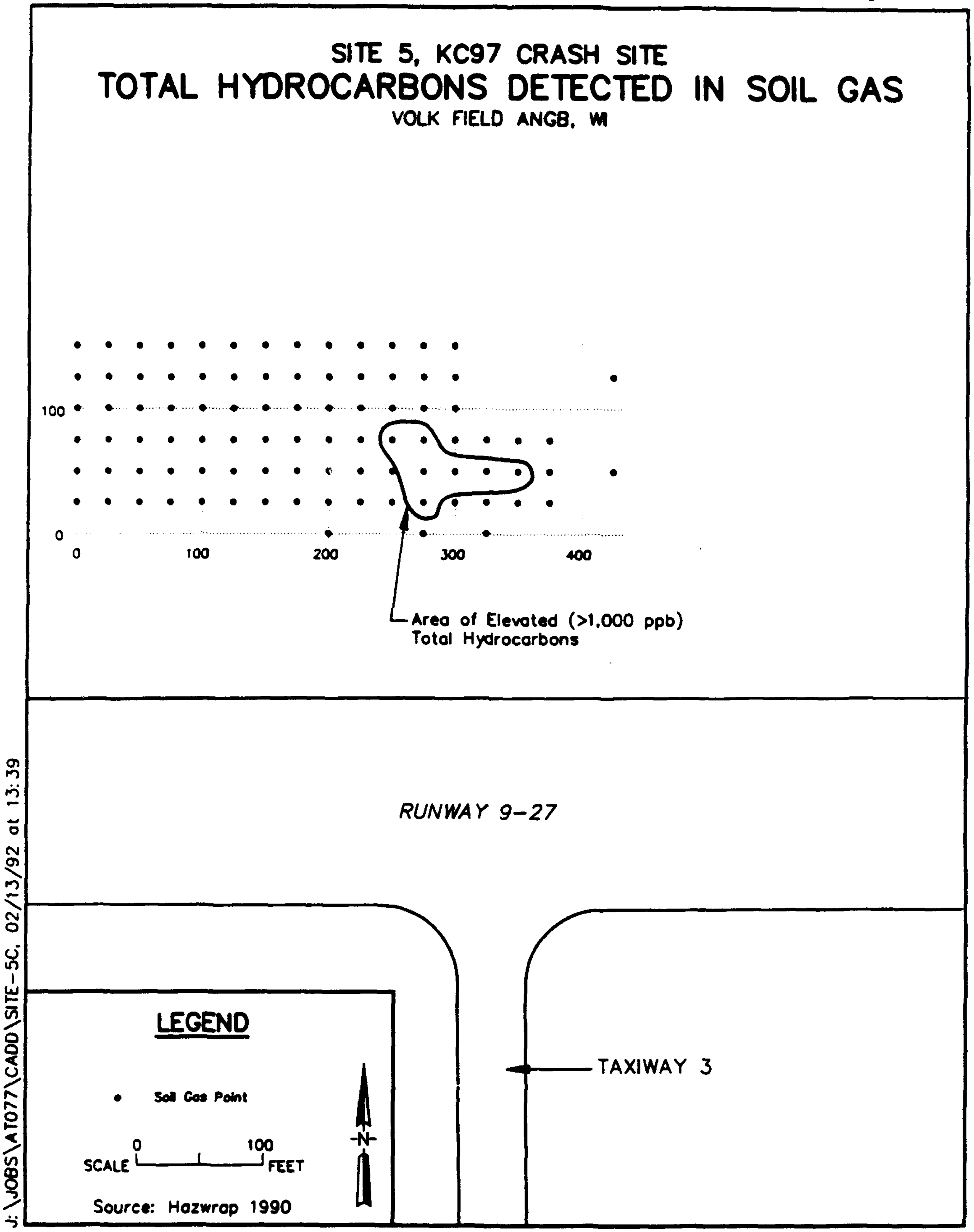
CONCLUSIONS AND RECOMMENDATIONS

The soil gas survey and subsequent soil sampling identified a small area of contaminated soil. No groundwater contaminants were detected. A comparison of the maximum detected contaminant concentration with the ARARs introduced in Tables 4.1 through 4.4 is presented in Table 9.33. No unacceptable risks were identified by the human health evaluation conducted for this site; therefore, it is recommended that a No-Further-Action Decision Document be prepared for this site.



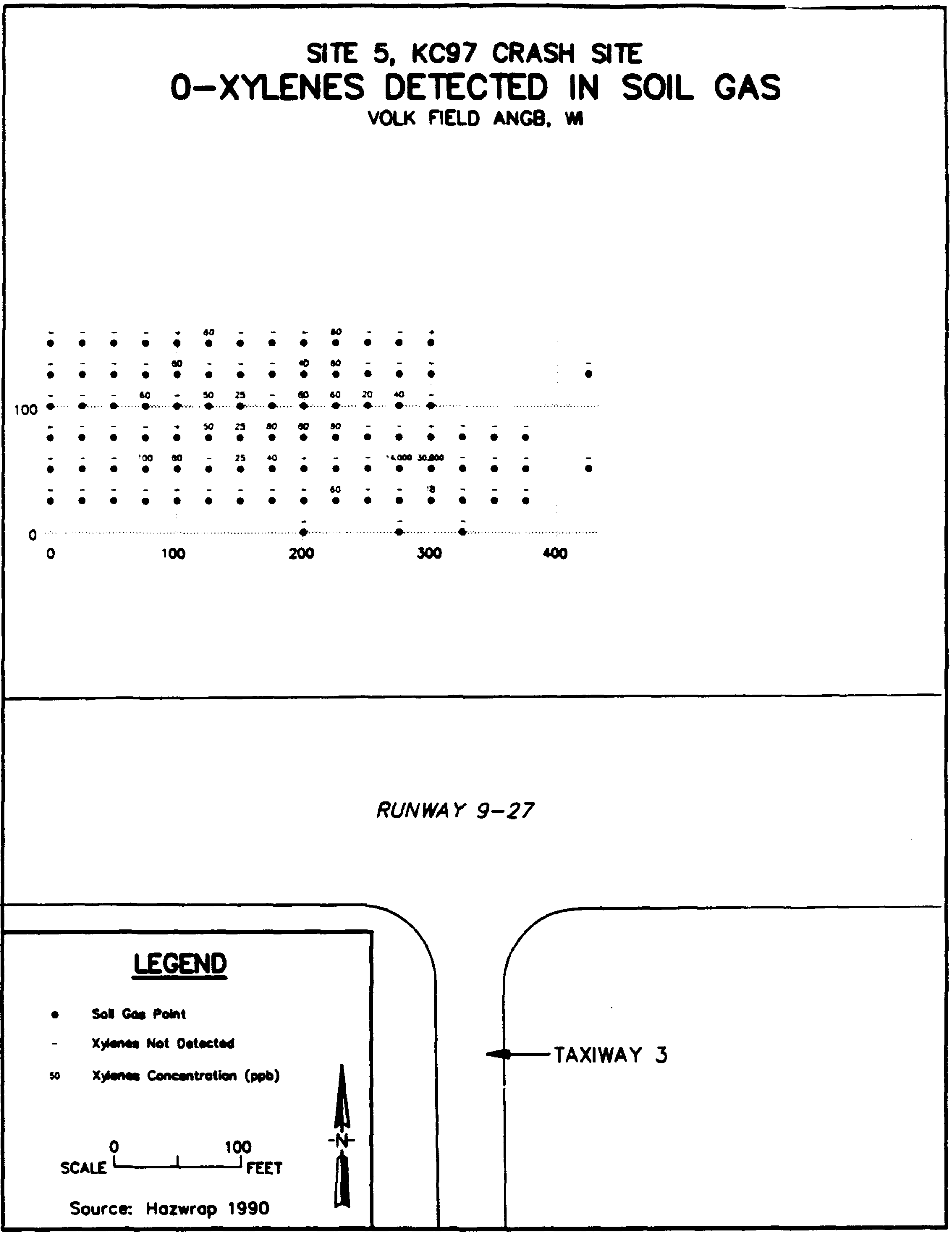
ENGINEERING-SCIENCE

Figure 9.2



ENGINEERING-SCIENCE

Figure 9.3



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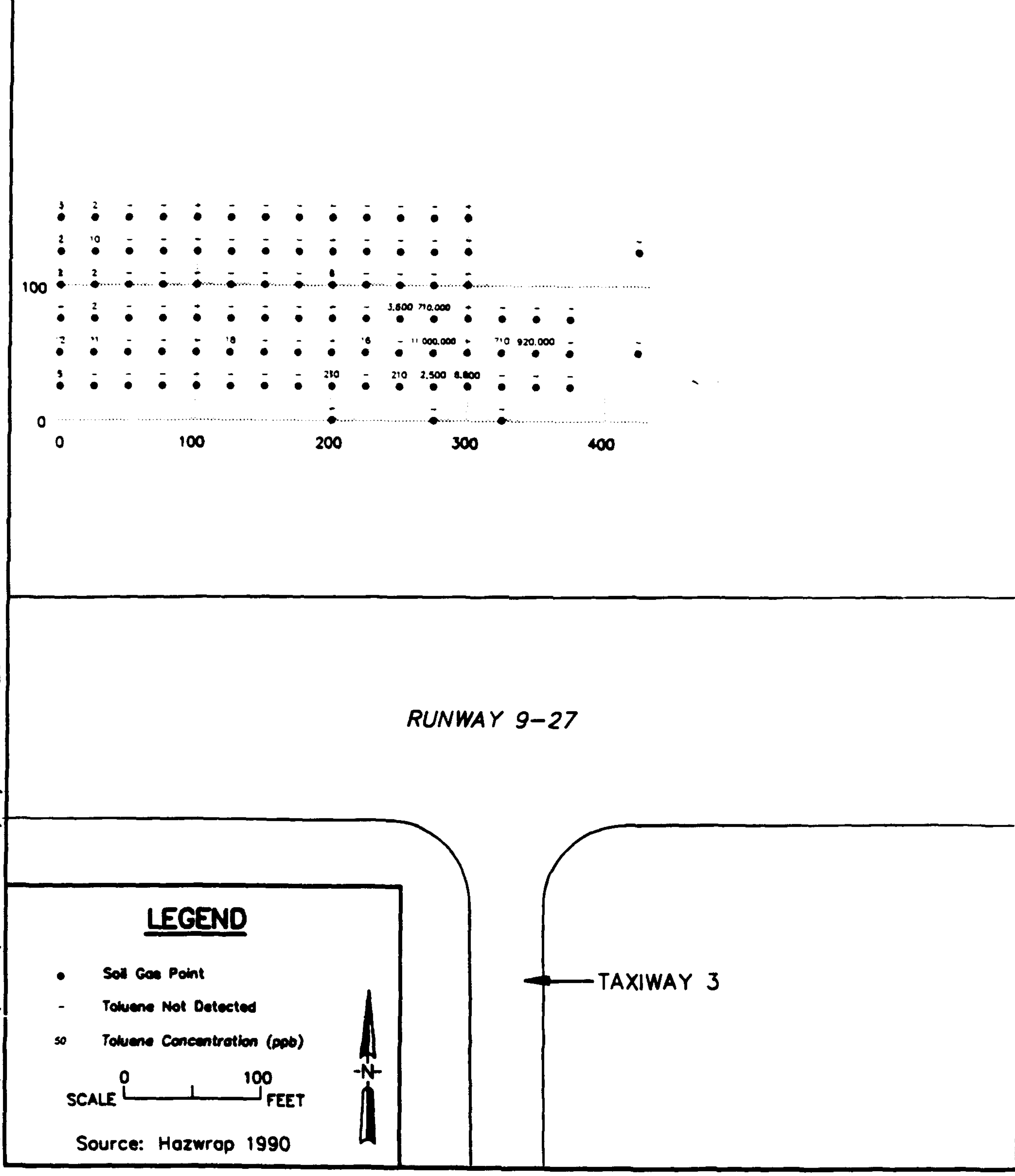
ENGINEERING-SCIENCE

Figure 9.4

SITE 5, KC97 CRASH SITE
TOLUENE DETECTED IN SOIL GAS
VOLK FIELD ANGB, WI



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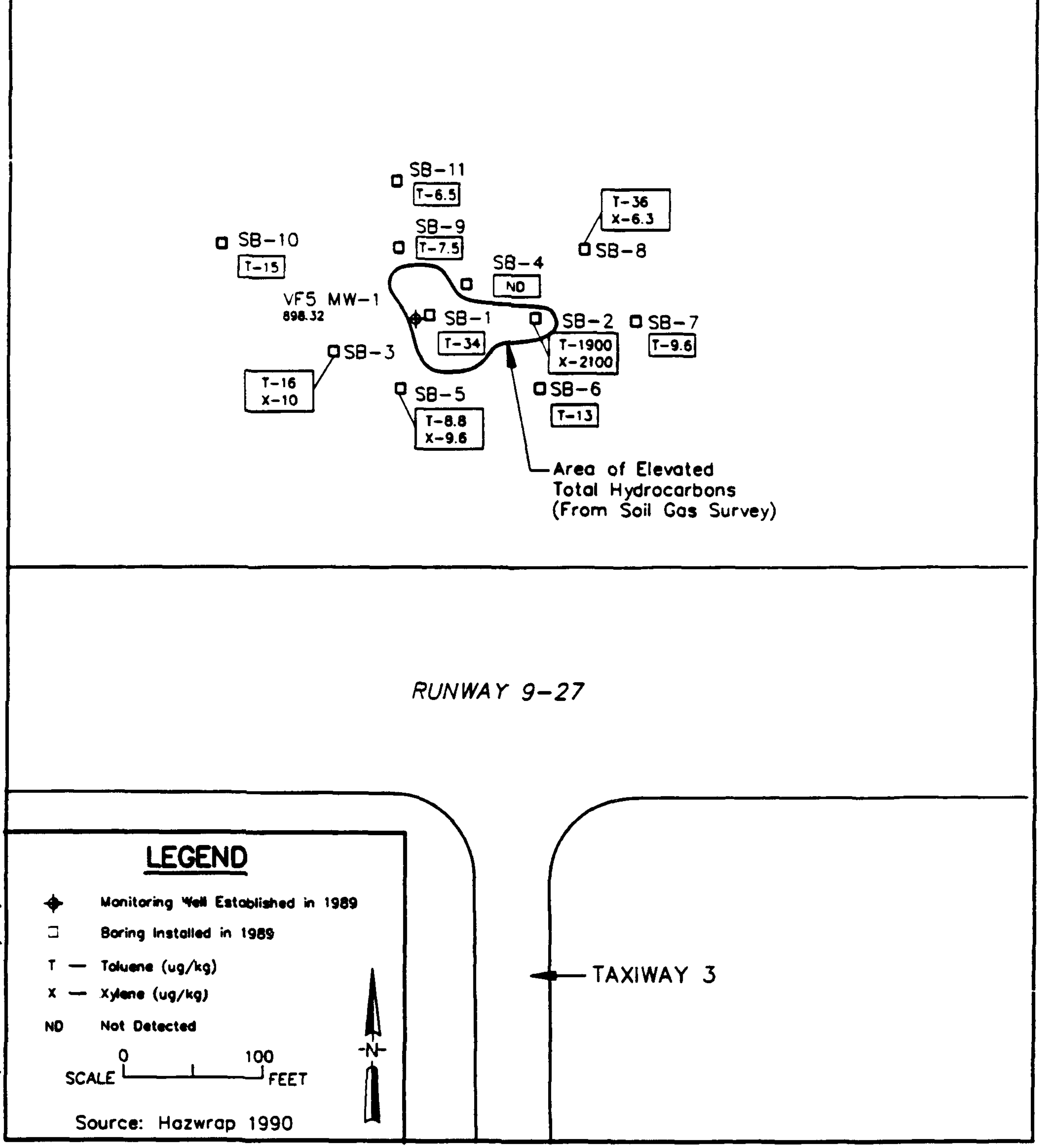
SITE 5, KC97 CRASH SITE
VOLATILE ORGANIC COMPOUNDS DETECTED IN SOIL SAMPLES (3.5–6.0 FT.)
VOLK FIELD ANGB, WI



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ENGINEERING-SCIENCE

TABLE 9.1
SITE 5, KC97 CRASH SITE
DETECTED ANALYTES IN SOIL SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF5 SB1 SS1 (0-1.0)	VF5 SB1 SS2 (3.5-5.5)	VF5 SB2 SS1 (0-2.0)	VF5 SB2 SS2 (3.5-5.5)	VF5 SB2 SS1 (5.5-8.0)	VF5 SB3 SS1 (3.5-6.0)	VF5 SB4 SS1 (0-2.5)	VF5 SB4 SS2 (3.5-6.0)
Date Sampled	11/04/89	11/04/89	11/04/89	11/04/89	11/04/89	11/04/89	11/04/89	11/04/89
Halogenated Volatiles - SW8010 (ug/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/kg)								
Toluene	15J2,J4	34J2,J4	U	1900J2	12J2	16J2	U	U
Xylenes	8.6J2,J4	U	U	2100J2	U	10J2	U	U
Total Petroleum Hydrocarbons E418.1 (mg/kg)	17	58	U	23	U	U	U	23
Lead - SW7421 (mg/kg)	100	25	2.5	5.7	1.6	6.9	2.1	0.95

Parameter	VF5 SB5 SS1 (3.5-6.0)	VF5 SB6 SS1 (3.5-6.0)	VF5 SB7 SS1 (3.5-6.0)	VF5 SB8 SS1 (0-2.0)	VF5 SB8 SS2 (3.5-6.0)	VF5 SB9 SS1 (3.5-6.0)	VF5 SB10 SS1 (3.5-6.0)	VF5 SB11 SS1 (3.5-6.0)
Date Sampled	11/05/89	11/05/89	11/05/89	11/05/89	11/05/89	11/05/89	11/05/89	11/05/89
Halogenated Volatiles - SW8010 (ug/kg)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/kg)								
Toluene	8.8J2	13J2,J4	9.6J2	15J2	36J2	7.5J2,J4	15J2,J4	6.5J2
Xylenes	9.6J2	U	U	11J2	6.3J2	U	U	U
Total Petroleum Hydrocarbons E418.1 (mg/kg)	27	25	50	18	34	18	16	17
Lead - SW7421 (mg/kg)	2.4	4.3	2.0	5.8	2.2	6.3	3.5	4.4

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E

TABLE 9.2
SITE 5, KC97 CRASH SITE
DETECTED ANALYTES IN
GROUNDWATER SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF5-MW1	VF5-MW20*
Date Sampled	11/09/89	11/09/89
Halogenated Volatiles - SW8010 (ug/L)	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U
Total Dissolved Solids - E160.1 (mg/L)	130	140
Dissolved Lead - SW7421 (ug/L)	U	U

ND - No analytes detected for this method.
U - Below the detection limit.
* Duplicate of VF5-MW1.

TABLE 9.3
SITE 5, KC97 CRASH SITE
DETECTED ANALYTES IN
GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF5-MW1
Date Sampled	10/29/90
Aromatic Volatiles - SW8020 (ug/L)	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U
Dissolved Lead - SW7421 (ug/L)	U
Total Dissolved Solids - E160.1 (mg/L)	160

ND - No analytes detected for this method.
U - Below the detection limit.

TABLE 9.4
SITE 5, KC97 CRASH SITE
CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS (TOP 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Maximum Detected Concentration (a) (mg/kg)
Lead	2.1-100	4 / 4	2.76E+01	4.18E+01	1.00E+02
Petroleum Hydrocarbons	17-18	2 / 4	1.13E+01	6.26E+00	1 80E+01
Toluene	0.015	2 / 4	8.75E-03	6.25E-03	1.50E-02
Xylenes	0.0086-0.011	2 / 4	6.15E-03	3.75E-03	1.10E-02

(a) Sample size is less than 5 (n < 5), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 9.5
SITE 5, KC97 CRASH SITE
CHEMICALS OF CONCERN DETECTED IN DEEP SOILS (> 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	95% Upper Confidence Limit (a) (mg/kg)
Lead	0.95-25	12 / 12	5.44E+00	6.18E+00	9.36E+00
Petroleum Hydrocarbons	16-58	10 / 12	2.51E+01	1.53E+01	3.48E+01
Toluene	0.0065-1.9	11 / 12	1.72E-01	5.21E-01	5.03E-01
Xylene	0.0063-2.1	4 / 12	1.79E-01	5.79E-01	5.47E-01

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 9.6

SITE 5, KC97 CRASH SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/ fugitive dust generation	Site 5; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Low concentrations of VOC's were detected in soils. Lead concentrations are well below EPA's risk-based cleanup target of 500 ppm. Access to site is restricted except for an occasional base worker.
	Contaminated soils/fugitive dust generation	Site 5; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Low levels of lead were detected in surface soils. However the site is heavily vegetated and receptors are only present occasionally.
Groundwater	Contaminated soils/leaching to groundwater	Downgradient wells	Onsite workers, nearby residents	Oral, dermal, inhalation	Unlikely. No contamination was detected in the monitoring well.
Surface Water	Contaminated soils/ surface runoff	Lemonwier River	Onsite workers, nearby residents	Oral, dermal, inhalation	Unlikely. There is a low level of contamination, a lack of surface water at the site, and a large distance to the river (>2 miles).
Soils	Contaminated soils/leaching, runoff, tracking	Site 5	Onsite workers	Oral, dermal	Low. Low levels of contaminants were detected, but the site is heavily vegetated and receptors are not frequently present.
FUTURE USE SCENARIOS					
Air	Contaminated soils, fugitive dust generation	Site 5; areas downwind	Future residents, onsite workers	Inhalation	Very low. VOC's are likely to disperse. Lead concentrations are well below EPA's risk-based cleanup target of 500 ppm.

TABLE 9.6–Continued

SITE 5, KC97 CRASH SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS (Cont'd)					
Groundwater	Contaminated soils/leaching to groundwater	Wells onsite or downgradient	Future residents, onsite workers	Oral, dermal, inhalation	Unlikely. No groundwater contamination was detected.
Surface Water	Contaminated soil/ surface runoff	Lemonwier River	Future residents	Oral, dermal, inhalation	Unlikely. There is a low level of contamination, a lack of surface water at the site, and a large distance to the river (>2 miles).
Soils	Contaminated soils/leaching, runoff, tracking	Site 5	Future residents, onsite workers	Oral, dermal	Very low. Low levels of contamination are present and will disperse with time. It is unlikely that homes would be developed here unless the airfield ceases to operate.

TABLE 9.7
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.00E+02	1.10E-06	1.10E-04	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.8
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	1.28E-05	1.28E-03	ND	NA
Petroleum Hydrocarbons	1.80E+01	1.28E-05	2.30E-04	ND	NA
Toluene	1.50E-02	1.28E-05	1.92E-07	2.00E-01	9.60E-07
Xylene	1.10E-02	1.28E-05	1.41E-07	2.00E+00	7.04E-08
				HAZARD INDEX =	1E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.9
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.00E+02	3.49E-07	3.49E-05	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.10
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	9.78E-07	9.78E-05	ND	NA
Petroleum Hydrocarbons	1.80E+01	9.78E-07	1.76E-05	ND	NA
Toluene	1.50E-02	9.78E-07	1.47E-08	2.00E-01	7.34E-08
Xylene	1.10E-02	9.78E-07	1.08E-08	2.00E+00	5.38E-09
				HAZARD INDEX =	8E-08

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.11
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical Specific Risk
Lead	1.00E+02	5.87E-07	5.87E-05	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.12
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	1.37E-06	1.37E-04	ND	NA
Petroleum Hydrocarbons	1.80E+01	1.37E-06	2.47E-05	ND	NA
Toluene	1.50E-02	1.37E-06	2.06E-08	2.00E-01	1.03E-07
Xylene	1.10E-02	1.37E-06	1.51E-08	2.00E+00	7.54E-09
				HAZARD INDEX =	1E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.13
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical Specific Risk
Lead	1.00E+02	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.14
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.80E+01	1.86E-05	3.35E-04	ND	NA
Toluene	1.50E-02	1.86E-05	2.79E-07	2.00E-01	1.40E-06
Xylene	1.10E-02	1.86E-05	2.05E-07	2.00E+00	1.02E-07
				HAZARD INDEX =	1E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.15
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.00E+02	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.16
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.80E+01	6.64E-06	1.20E-04	ND	NA
Toluene	1.50E-02	6.64E-06	9.96E-08	2.00E-01	4.98E-07
Xylene	1.10E-02	6.64E-06	7.30E-08	2.00E+00	3.65E-08
				HAZARD INDEX =	5E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.17
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	1.00E+02	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.18
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	1.00E+02	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	1.80E+01	2.20E-06	3.96E-05	ND	NA
Toluene	1.50E-02	2.20E-06	3.30E-08	2.00E-01	1.65E-07
Xylene	1.10E-02	2.20E-06	2.42E-08	2.00E+00	1.21E-08
				HAZARD INDEX =	2E-07

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.19
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	1.10E-06	1.03E-05	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 9.20
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	9.36E+00	1.28E-05	1.20E-04	ND	NA
Petroleum Hydrocarbons	3.48E+01	1.28E-05	4.45E-04	ND	NA
Toluene	5.03E-01	1.28E-05	6.44E-06	2.00E-01	3.22E-05
Xylene	5.47E-01	1.28E-05	7.00E-06	2.00E+00	3.50E-06
				HAZARD INDEX =	4E-05

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.21
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	3.49E-07	3.27E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 9.22
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Harard Quotient
Lead	9.36E+00	9.78E-07	9.16E-06	ND	NA
Petroleum Hydrocarbons	3.48E+01	9.78E-07	3.40E-05	ND	NA
Toluene	5.03E-01	9.78E-07	4.92E-07	2.00E-01	2.46E-06
Xylene	5.47E-01	9.78E-07	5.35E-07	2.00E+00	2.67E-07
				HAZARD INDEX =	3E-06

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND – Not Determined
NA – Not Applicable

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TABLE 9.23
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	5.87E-07	5.50E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.24
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Lead	9.36E+00	1.37E-06	1.28E-05	ND	NA
Petroleum Hydrocarbons	3.48E+01	1.37E-06	4.77E-05	ND	NA
Toluene	5.03E-01	1.37E-06	6.89E-07	2.00E-01	3.44E-06
Xylene	5.47E-01	1.37E-06	7.49E-07	2.00E+00	3.75E-07
				HAZARD INDEX =	4E-06

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 9.25
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM DEEP SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.26
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY CHILDREN (a)
VOLK FILE ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	9.36E+00	NA	NA	ND	NA
Petroleum Hydrocarbons	3.48E+01	1.86E-05	6.47E-04	ND	NA
Toluene	5.03E-01	1.86E-05	9.35E-06	2.00E-01	4.68E-05
Xylene	5.47E-01	1.86E-05	1.02E-05	2.00E+00	5.09E-06
				HAZARD INDEX =	5E-05

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.27
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.28
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	9.36E+00	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	3.48E+01	6.64E-06	2.31E-04	ND	NA
Toluene	5.03E-01	6.64E-06	3.34E-06	2.00E-01	1.67E-05
Xylene	5.47E-01	6.64E-06	3.63E-06	2.00E+00	1.82E-06
				HAZARD INDEX =	2E-05

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.29
SITE 5, KC97 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	9.36E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.30
SITE 5, KC97 CRASH SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM DEEP SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Lead	9.36E+00	NA (e)	NA	ND	NA
Petroleum Hydrocarbons	3.48E+01	2.20E-06	7.65E-05	ND	NA
Toluene	5.03E-01	2.20E-06	1.11E-06	2.00E-01	5.53E-06
Xylene	5.47E-01	2.20E-06	1.20E-06	2.00E+00	6.02E-07
				HAZARD INDEX =	6E-06

(a) Based on compounds detected deeper than 2 feet.
(b) Concentration in soil represents the upper 95th percent confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 9.31
SITE 5, KC97 CRASH SITE
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Pathway Risk	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Deep Soils	NQ (a)	--
	Dermal Absorption from Deep Soils	NQ (a)	--
	Incidental Ingestion of Surface Soils	NQ (a)	--
	Dermal Absorption from Surface Soils	NQ (a)	--
Future Onsite Workers	Incidental Ingestion of Deep Soils	NQ (a)	--
	Dermal Absorption from Deep Soils	NQ (a)	--
	Incidental Ingestion of Surface Soils	NQ (a)	--
	Dermal Absorption from Surface Soils	NQ (a)	--
Future Adult Residents	Incidental Ingestion of Deep Soils	NQ (a)	--
	Dermal Absorption from Deep Soils	NQ (a)	--
	Incidental Ingestion of Surface Soils	NQ (a)	--
	Dermal Absorption from Surface Soils	NQ (a)	--
Future Children	Incidental Ingestion of Deep Soils	NQ (a)	--
	Dermal Absorption from Deep Soils	NQ (a)	--
	Incidental Ingestion of Surface Soils	NQ (a)	--
	Dermal Absorption from Surface Soils	NQ (a)	--

(a) Not Quantifiable; there is no oral slope factor for lead.

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TABLE 9.32
SITE 5, KC97 CRASH SITE
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Deep Soils	3E-06	Toluene
	Dermal Absorption from Deep Soils	2E-05	Toluene
	Incidental Ingestion of Surface Soils	8E-08	Toluene
	Dermal Absorption from Surface Soils	5E-07	Toluene
Future Onsite Workers	Incidental Ingestion of Deep Soils	3E-06	Toluene
	Dermal Absorption from Deep Soils	2E-05	Toluene
	Incidental Ingestion of Surface Soils	8E-08	Toluene
	Dermal Absorption from Surface Soils	5E-07	Toluene
Future Adult Residents	Incidental Ingestion of Deep Soils	4E-06	Toluene
	Dermal Absorption from Deep Soils	6E-06	Toluene
	Incidental Ingestion of Surface Soils	1E-07	Toluene
	Dermal Absorption from Surface Soils	2E-07	Toluene
Future Children	Incidental Ingestion of Deep Soils	4E-05	Toluene
	Dermal Absorption from Deep Soils	5E-05	Toluene
	Incidental Ingestion of Surface Soils	1E-06	Toluene
	Dermal Absorption from Surface Soils	1E-06	Toluene

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TABLE 9.33

CHEMICAL CONSTITUENTS DETECTED AT SITE 5
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Lead	1989	100	--	--	--
Toluene	1989	1.9	--	--	--
TPH	1989	58	--	--	--
Xylenes	1989	2.1	--	--	--
Groundwater (ug/L)					
TDS	1989, 1990	160,000	--	--	--

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SECTION 10
SITE 7 - FORMER LANDFILL A

BACKGROUND

This subsection presents a description of Site 7 along with a summary of the site investigations conducted under the IRP.

Site Description

Site 7 is an abandoned landfill located immediately south of Madison Boulevard in the eastern portion of the Base as shown on Figure 10.1. The landfill has not been used since the late 1940s or early 1950s [HMTC, 1984]. A small lake (not shown) was constructed approximately 700 feet east of Site 7 in 1989. Materials disposed at this site reportedly included fuels, solvents, paints, munitions and municipal refuse. Site 7 is approximately 1,500 feet from the nearest base property line and is situated on flat to gently sloping lands covered by grass, heavy underbrush, small trees and mature woods. The exact location of the landfill could not be determined from available records. However, the approximate location of the landfill was determined in the SI [ES, 1990c] using geophysics and observation of surface characteristics. Four such areas were identified and are denoted on Figure 10.1 and are discussed below.

Area 1 is an area encompassing approximately 35,000 square feet located immediately south of where Madison Boulevard bends northward. The area is slightly mounded and covered with various debris.

Area 2 is a tract roughly 500 feet long and 100 feet wide. It is located about 300 feet southeast of Area 1. Most of this tract was covered with construction debris in the past; however, during the 1990 effort it was noted that a large part of Area 2 had been excavated and/or graded.

Area 3 is a topographic depression which may contain construction debris on the western side of Site 7. This low area is approximately 200 feet east of the north-south trending fence that encloses the munitions storage area. The depression may be the result of the excavation or subsidence of fill material.

Area 4 is a fourth possible location for buried waste material which was previously identified [HMTC, 1984] north of the munitions storage area.

1987 Field Activities

The SI was conducted at Site 7 in 1987. Field activities included geophysics and installation and sampling of three monitoring wells. The results of the sampling did not detect contaminants in the groundwater at this site [ES, 1990c]; however, further work was required to complete the SI.

1989 Field Activities

Three monitoring wells were installed in 1989. The locations of these wells are indicated on Figure 10.1. Two wells (MW-4 and MW-5) were installed downgradient of the contaminant sources to confirm or deny the presence of groundwater contamination. These wells are screened from 13 to 28 feet. An upgradient well, MW-6, was also installed and is screened from 25 to 40 feet. Groundwater samples were not collected from these wells during the 1989 investigation. The locations of the three wells were surveyed upon completion of drilling activities.

1990 Field Activities

Activities performed in 1990 at Site 7 included exploratory hand augering, groundwater sampling and surveying. Twelve boreholes were hand augered to depths of 1 to 3 feet to determine the thickness of the landfill cover. Groundwater samples were obtained from the six previously installed monitoring wells and analyzed for halogenated and aromatic volatile organics, semivolatile organics, TPH, metals, pesticides and PCBs, TDS, and field parameters (pH, specific conductance, and temperature). The elevation of the small recreational lake east of Site 7 was surveyed after the completion of the boring and sampling activities.

1991 Field Activities

Groundwater measurements were obtained from the monitoring wells at Site 7 on 30 October 1991. No other field activities were conducted at Site 7 in 1991.

RESULTS

This subsection presents the results obtained during the investigations of Site 7.

Geology/Hydrogeology

Lithologic logging performed during the previous well installations indicates Site 7 is underlain by a fine, silty, yellowish Pleistocene sand which extends to a depth of 5 feet. Underlying the sand is a yellowish-brown, varved clay. This clay was encountered at every well and ranged in thickness from 5 to 15 feet. The clay and sand are interfingered, with sand usually occurring again below the clay layer. A yellowish-orange sandstone is present at approximately 20 feet in four of the six borings and is typically fine-grained and very friable. The locations of two hydrogeologic cross-sections for the site are shown on Figure 10.2. The cross-

sections are presented on Figures 10.3 and 10.4. Well construction logs are included in Appendix B.

Depth to groundwater ranges from 9 to 33 feet BLS. Groundwater elevations measured on 13 November 1990 indicate flow toward the northeast with an average horizontal gradient of 0.002 ft/ft (Figure 10.1). The estimated groundwater flow velocity for this site is 0.05 ft/day or 18.6 ft/yr, which is based on the hydraulic gradient, the hydraulic conductivity of 38 gpd/ft^2 or 5.0 ft/day (from slug test data) [ES, 1990c] and an effective porosity of 0.2 [Bouwer, 1978]. Elevation data and well construction details are presented in Table 2.4. A complete summary of the groundwater measurements including additional groundwater contour maps is found in Appendix B.

Soil Sampling Results

Twelve soil borings were augered to a depth of up to three feet in Areas 1 and 4 at Site 7. The locations of these borings are shown on Figure 10.5. No evidence of landfilled material was encountered in any of these borings. Three borings encountered what seemed to be native sandstone at depths between 0.75 and 2 feet. Large stones were recovered from a fourth boring at a depth of 2.5 to 3 feet.

Groundwater Sampling Results

Organic compounds were not detected in the groundwater samples collected from the six wells at Site 7. Dissolved copper, nickel and/or zinc were detected in samples from three of the wells with maximum levels of 117, 17.3 and 28.0 μg/L, respectively. Total dissolved solids detected in groundwater samples ranged from 37 to 410 mg/L. A summary of the analytical results is provided in Table 10.1 and depicted on Figure 10.5. The metals data obtained in 1988 were from unfiltered samples and are not directly comparable to the 1990 results.

BASELINE RISK ASSESSMENT

The following subsections present the Site 7 baseline risk assessment. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the risk assessment. Analytical results for groundwater samples collected in 1988 and 1990 were used in the preparation of this risk assessment. The risk assessment presented here was conducted according to the most recent EPA guidelines and considers all of the available site monitoring data through 1991.

Selection of Chemicals of Concern

Three metals were detected in groundwater samples associated with Site 7. Based on the chemicals detected in the 1988 and 1990 rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected. Although three monitoring wells were sampled in 1988 [ES, 1990c] this data was not incorporated into this risk assessment because no organics were

detected and the metals data is for unfiltered samples. This data is however presented in Appendix G. The available toxicity information for chemicals of concern are discussed in Section 4 and Appendix F.

Soils

No chemicals of concern were selected for soils since no soil samples were collected for analysis.

Groundwater

Dissolved copper was retained as a chemical of concern for groundwater at Site 7. Zinc and nickel were eliminated as their detected concentrations did not exceed three times the corresponding upgradient concentration or PQL. The arithmetic average, standard deviation and 95 percent UCL of the arithmetic average for copper are presented in Table 10.2.

Human Health Evaluation

The following subsections present the Site 7 human health evaluation.

Exposure Pathways

Potential sources for contaminant release at this site include the materials disposed at the site and any soils or groundwater containing chemical contaminants. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point.

Access to Site 7 is restricted by fencing on the north, west, and south sides, but one could drive onto the site from the east. No current exposure pathways exist for the site. However, hypothetical (future) exposure pathways would include exposures to: onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 7 are summarized in Table 10.3.

Soils. Current pathways involving exposure to soils are probably not complete since the site is vegetated. The heavy vegetation at the site retards wind erosion and reduces the potential for airborne contamination. However, since no soil samples were taken, it is impossible to completely evaluate this pathway. Given that no mobile, water soluble contaminants were detected in the groundwater, it is unlikely that such compounds are present in the soils at the site.

Groundwater. There are private water supply wells and a Base water supply well downgradient (northeast) of Site 7. The Base supply well (W-4) was

sampled for organic and inorganic contaminants and found free of contaminants. Given this consideration, it is unlikely that other water supply wells further downgradient are contaminated. However, copper was detected (at concentrations exceeding background) in monitoring wells immediately downgradient of the site and the future migration of this contaminant to downgradient supply wells is possible.

Surface Water. Site 7 lies within the Lemonwier River drainage basin, but surface water flows on or near this site only during rainfall events. The soils at Site 7 are sandy and not conducive to surface water runoff; therefore, contaminant migration via surface water runoff is not likely. Migration of contaminants from the site via groundwater discharge is possible, but given the low concentrations and nature of the contaminant (copper) present in groundwater and the distance to the river (more than 2 miles) or the small man-made lake (approximately 700 feet east of the site), it is unlikely that groundwater discharge would contribute detectable contamination to either.

Although the small recreational lake is a potential exposure point, a lack of analytical data for the lake water is not considered a significant data gap for the following reasons:

- surface water runoff from Site 7 to the lake is not probable;
- the compound of concern (copper) does not present an exposure risk due to volatilization or dermal contact; and
- incidental ingestion of water during swimming/recreational use of the lake would result in exposures less than those associated with ingestion of groundwater.

For these reasons, the surface water exposure pathway was not evaluated further.

Air. Neither air samples or soil samples were collected at this site. However, based on the limited (nonvolatile) contamination detected in site groundwater and the heavy vegetation on the site, contaminant releases are not expected to be a problem and are not therefore included in the human health evaluation.

In this assessment, risks and hazard indices were calculated only for the pathways given below. Inhalation and dermal exposures were not calculated since metals (i.e., which are not volatile and not absorbed through the skin) were the only contaminants detected.

Exposure Pathway	Group Affected	Noncarcinogenic Table No.
Ingestion of groundwater	Children	10.4
	Workers	10.5
	Adult residents	10.6

Risk Characterization

EPA has identified copper as a noncarcinogenic chemical and has established a drinking water standard of 1.3 mg/L for it. However, the EPA group working on the Drinking Water Criteria Document for copper concluded that available toxicity data were inadequate for calculation of an RfD for copper. Copper was the only chemical of concern detected at this site and because an RfD has not been established for copper, the noncarcinogenic risks associated with ingestion of this chemical in site groundwater could not be quantitatively assessed. However, copper concentrations detected in site groundwater can be qualitatively assessed by comparing detected copper levels to the drinking water standard (1.3 mg/L). The detected copper concentrations are orders of magnitude less than the drinking water standard and these levels should not therefore present a noncarcinogenic risk for future human receptors.

Ecological Evaluation

Vegetative cover at Site 7 include grasslands, northern hardwood and aspen. Stands of northern hardwoods and oak are found directly north of the landfill. A wetland area characterized by bottomland hardwoods, lowland brush and marsh are located to the east of the landfill. Ecological receptors supported by these habitats are summarized in Section 4.

Exposure Assessment

The primary exposure pathway for ecological receptors at Site 7 is the uptake of contaminants in groundwater by plants. The extent to which exposure could occur resulting from contact with soils or surface water is unknown due to the lack of characterization data for these media. However, given that no mobile, water soluble contaminants were detected in the groundwater, it is unlikely that such compounds are present in the soils or the surface water at or near the site.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in groundwater. No chemicals of concern were identified for

soils and surface water for the ecological evaluation. Therefore, impacts to flora and fauna were not assessed for these potential exposure pathways.

Risk Characterization

Chemicals of concern were only identified for groundwater. However, there are no criteria to evaluate the potential impacts to flora and fauna from the intake of chemicals from groundwater.

Risk Assessment Conclusions

This subsection presents the conclusions and uncertainties of the baseline risk assessment.

Human Receptors

Copper was detected in groundwater at Site 7 at concentrations which exceeded background levels. No current human exposure pathways are associated with use of site groundwater. Hypothetical (future) human exposure pathways include ingestion of contaminants in groundwater by future residents and onsite workers. Copper does not currently have an RfD established for it, and noncarcinogenic risks for copper concentrations found in site groundwater cannot be estimated. However, the maximum copper concentrations detected were orders of magnitude less than the drinking water standard for copper. Therefore, health risks for future ingestion of groundwater are not expected.

Ecological Receptors

It is not possible to characterize risks associated with contaminants detected in groundwater at Site 7 due to the lack of reference toxicity information. It is also not possible to determine whether or not exposure pathways exist for ecological receptors in contact with soils or surface water due to the lack of characterization data for these media. However, given that no mobile, water soluble contaminants were detected in the groundwater, it is unlikely unacceptable risks exist for ecological receptors at this site.

CONCLUSIONS AND RECOMMENDATIONS

No landfill material is evident at Areas 1, 3 or 4 with the exception of some scattered loose debris at Area 1. Much of Area 2 has been excavated; however, some material is still piled on the edges or scattered in the trees.

The compounds detected in groundwater at Site 7, including those detected during the 1988 sampling effort [ES, 1990c], are presented in Table 10.7. This table also provides a comparison of the maximum detected concentrations to ARARs introduced in Tables 4.1 through 4.10. ARARs exceeded at this site include Wisconsin Enforcement Standards and Federal MCLs. Compounds detected in groundwater which exceeded ARARs include arsenic, cadmium, chromium and lead. These four metals were all collected during the 1988 sampling effort are from

unfiltered samples. None of the dissolved metals detected exceeded ARARs. No unacceptable risks were identified by the human health evaluation conducted for this site; therefore a No-Further-Action Decision Document should be prepared for Site 7.

Figure 10.1

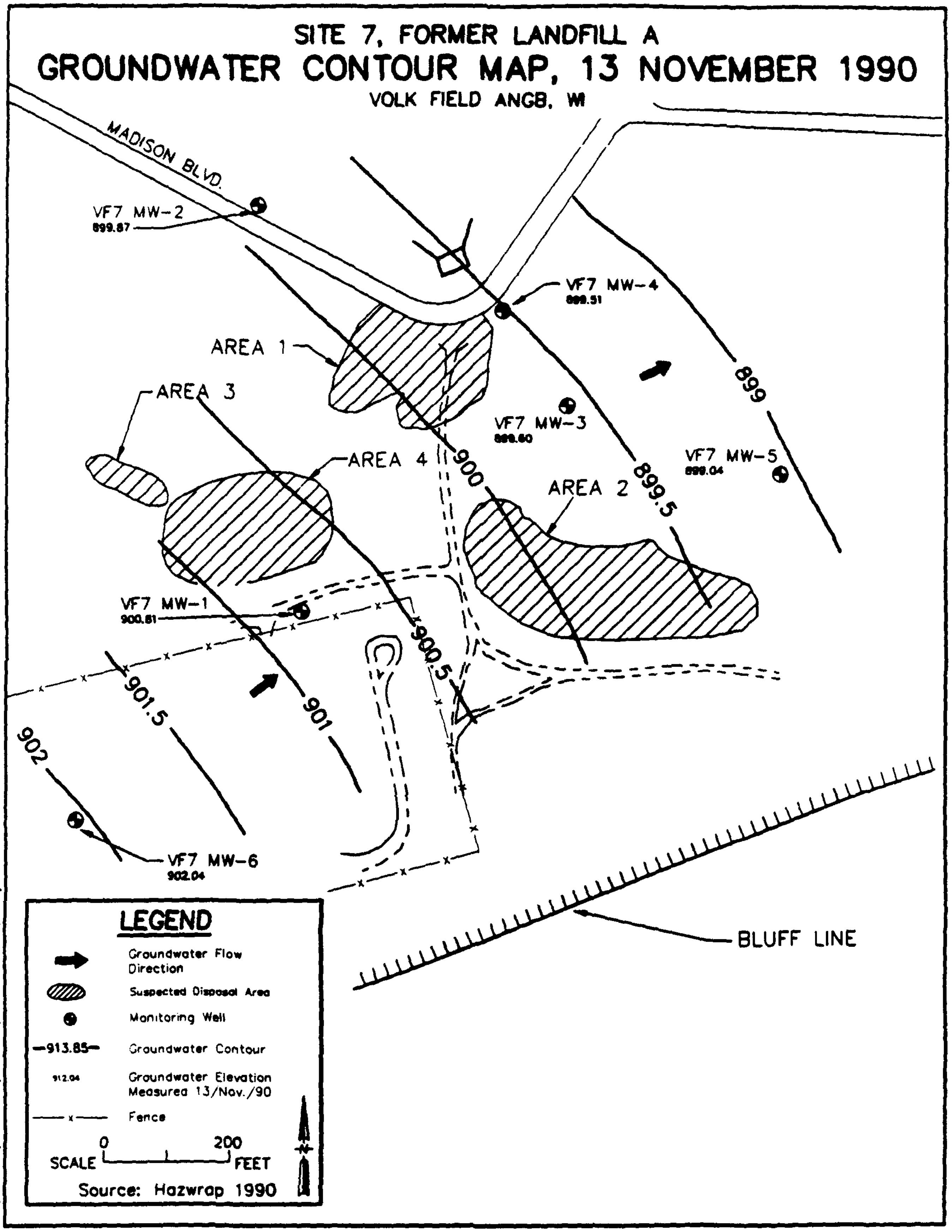

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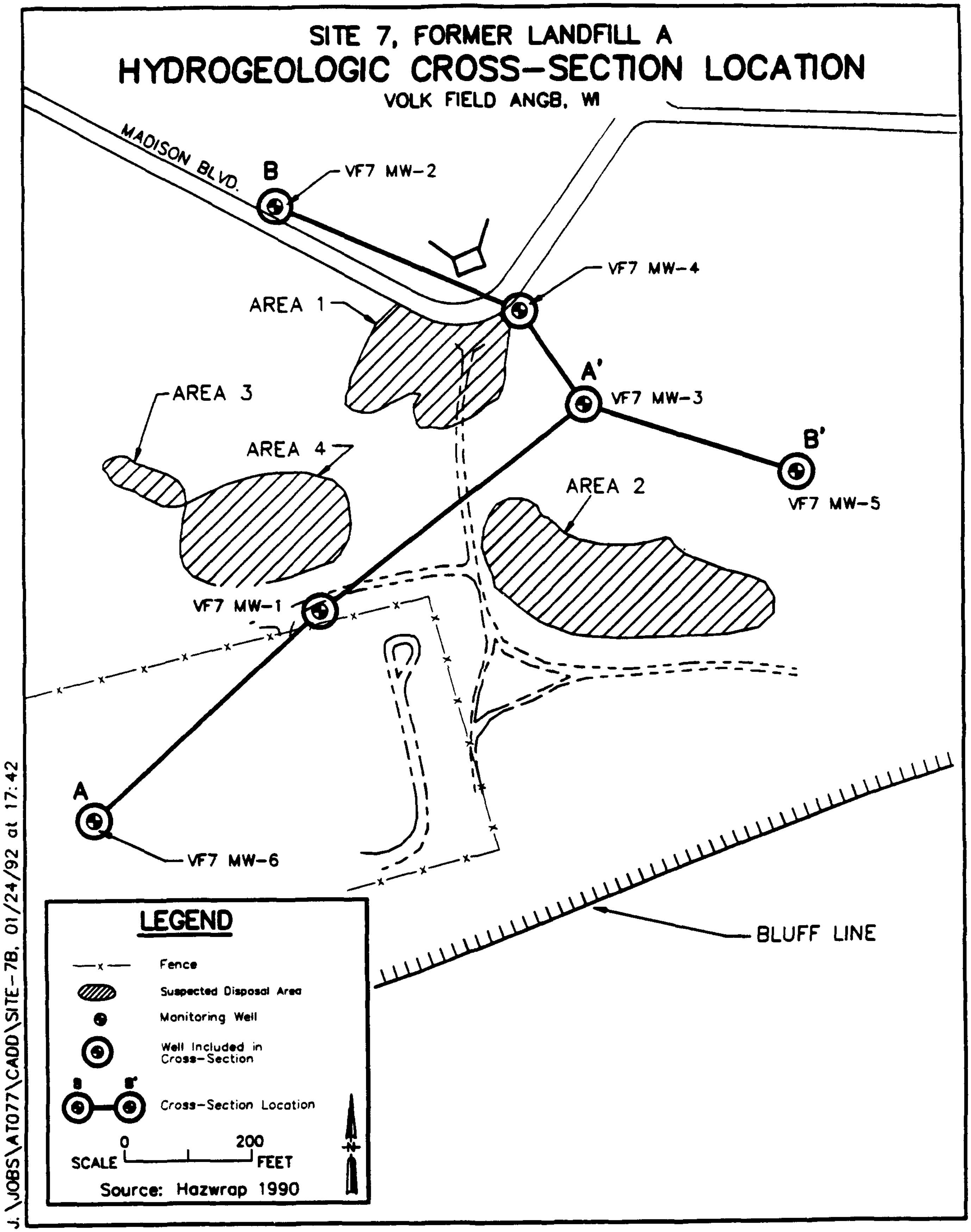
Figure 10.2



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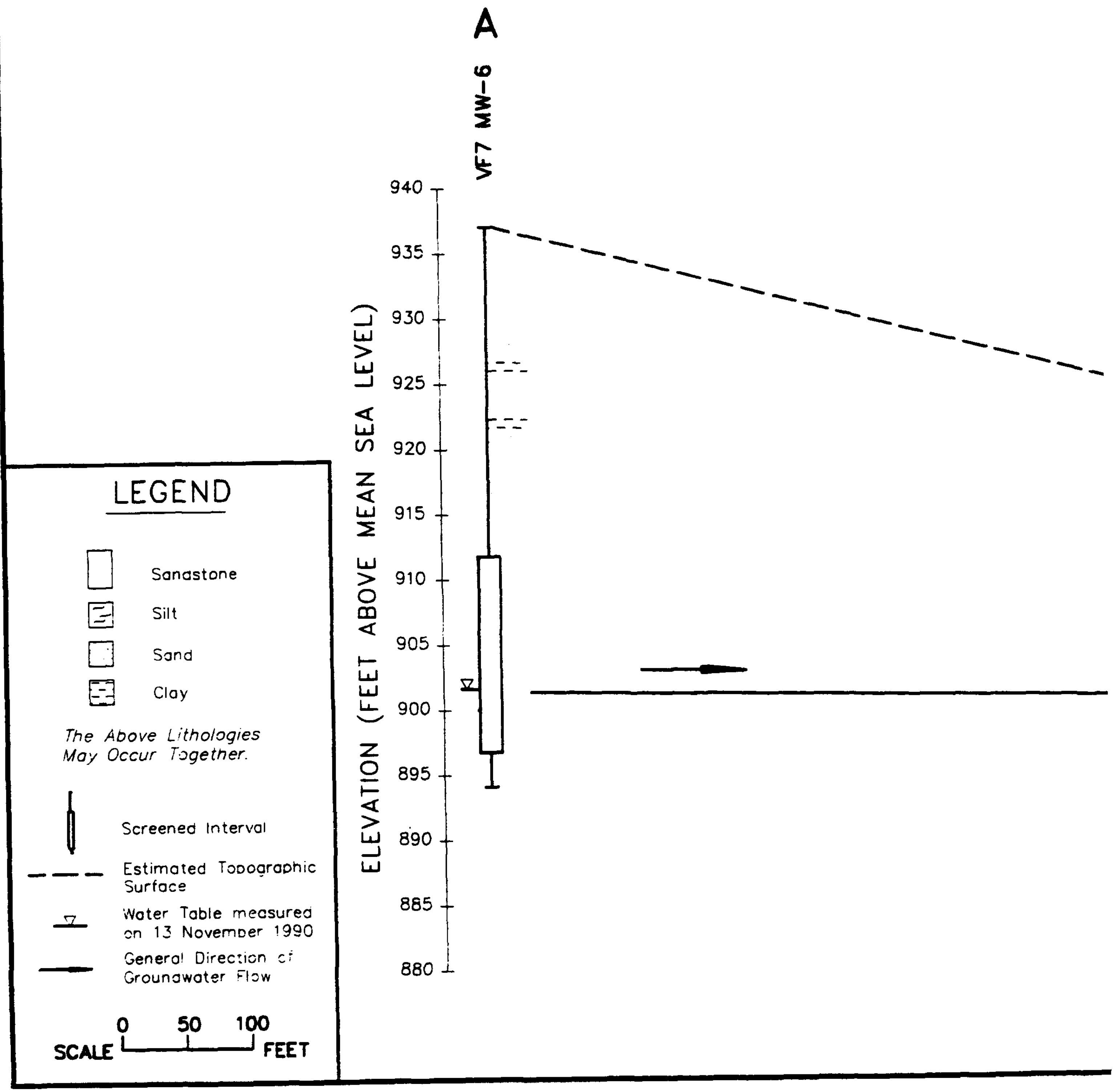
SITE 7, FORMER LA

HYDROGEOLOGIC CROSS

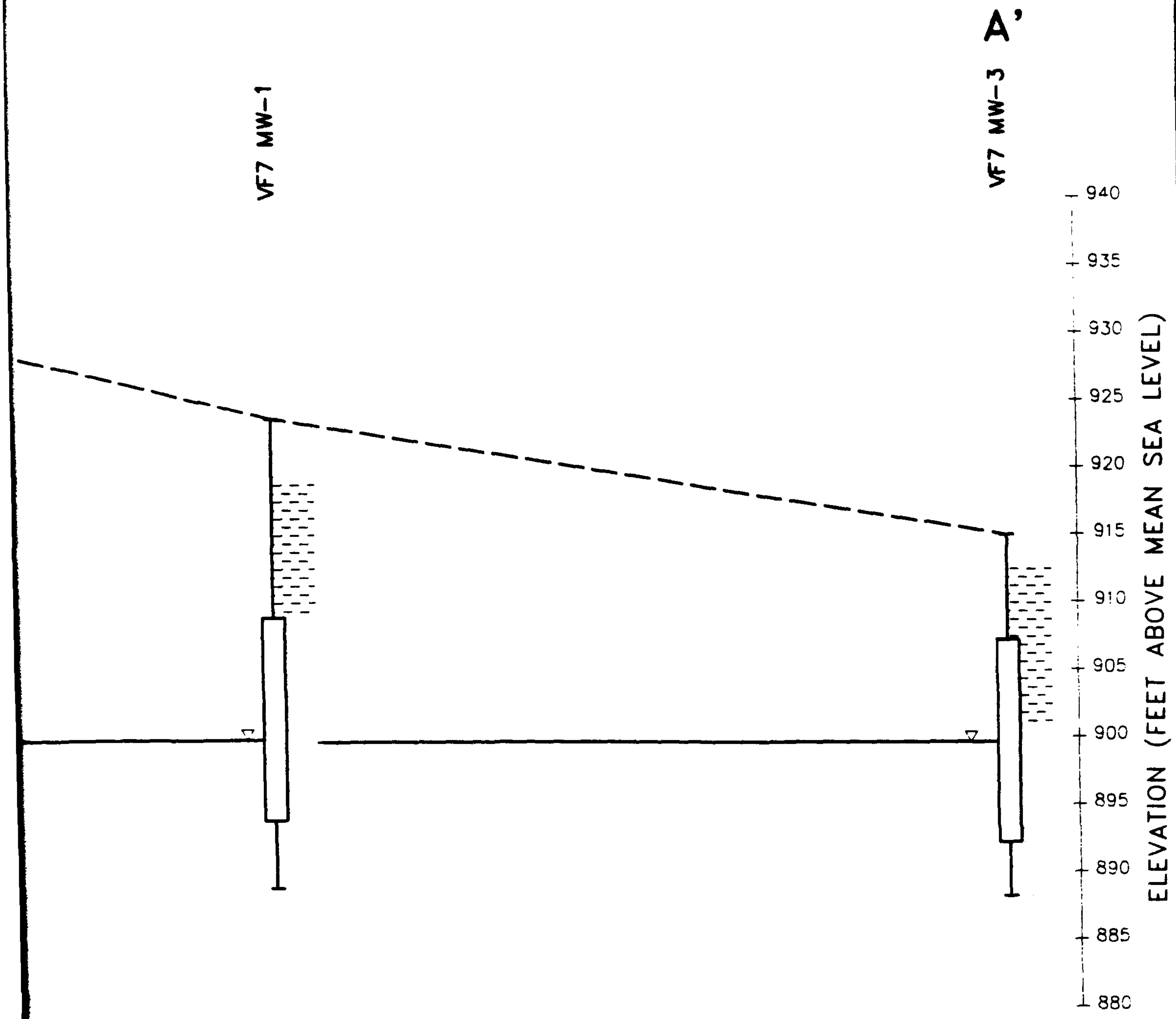
VOLK FIELD ANGB



7. FORMER LANDFILL A

OGIC CROSS SECTION A–A'

VOLK FIELD ANGB, WI



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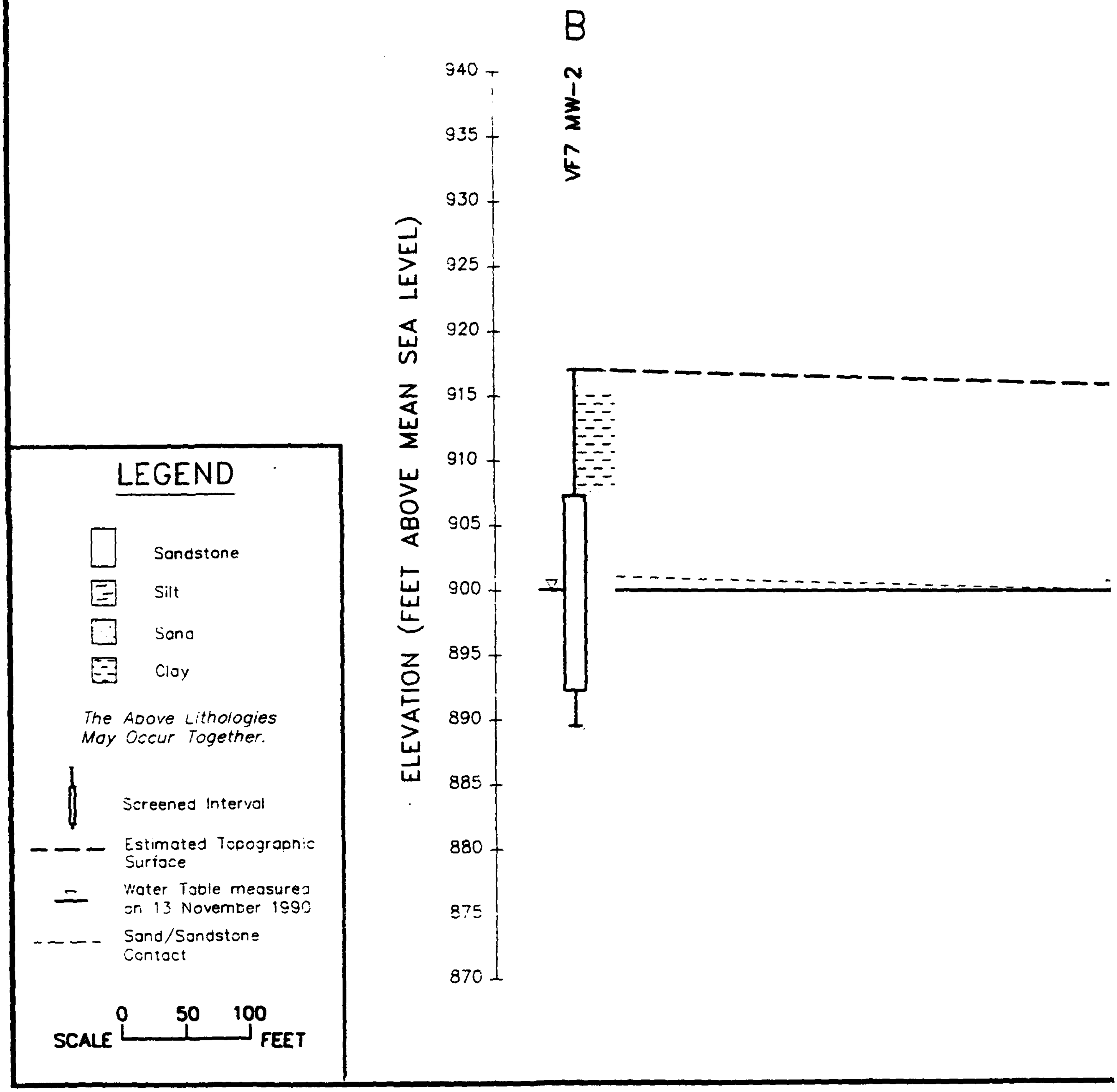
SITE 7, FORMER LA

HYDROGEOLOGIC CROSS

VOLK FIELD ANGB,



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7, FORMER LANDFILL A

DGIC CROSS SECTION B–B'

VOLK FIELD ANGB, WI

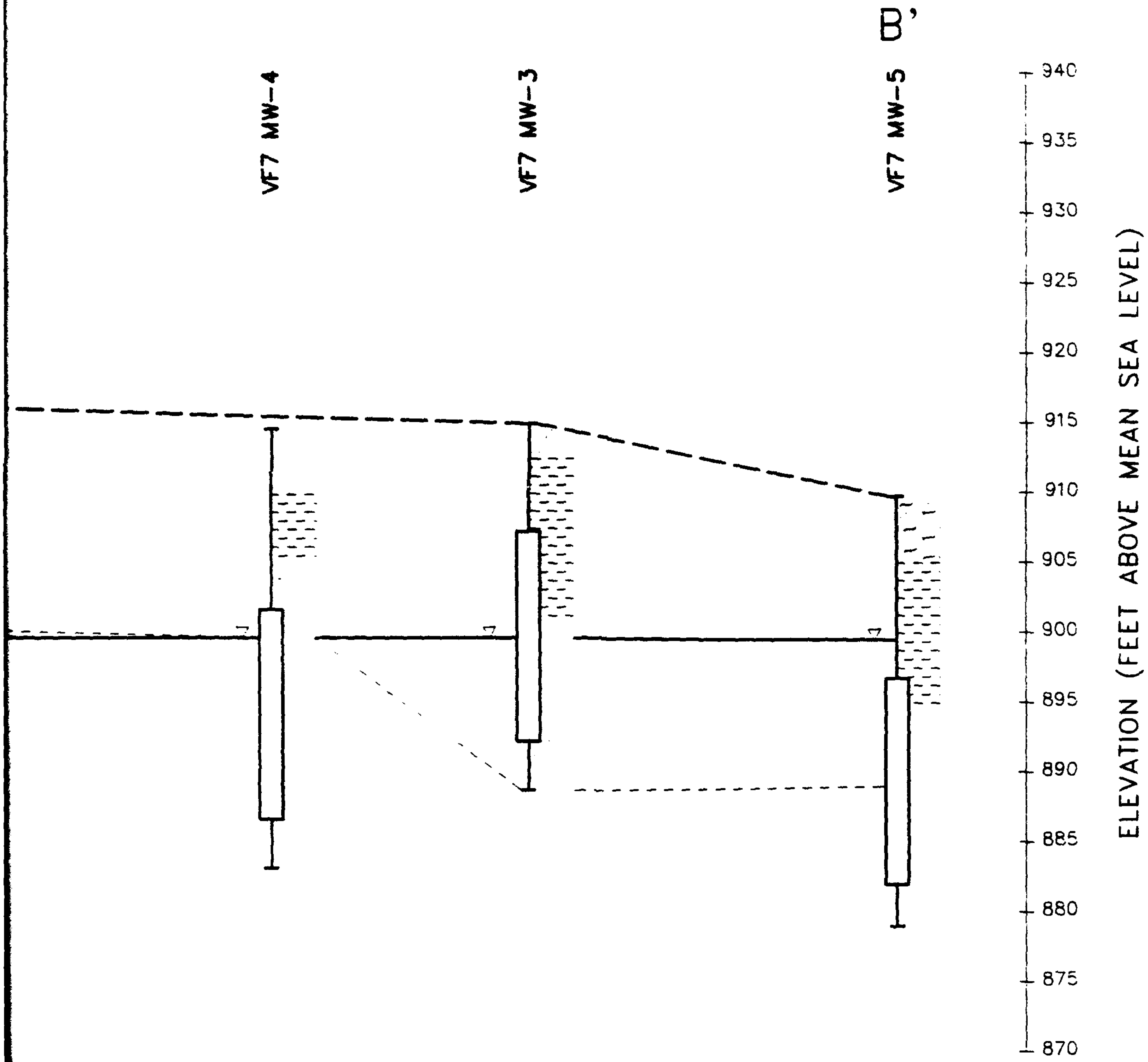

Figure 10.5

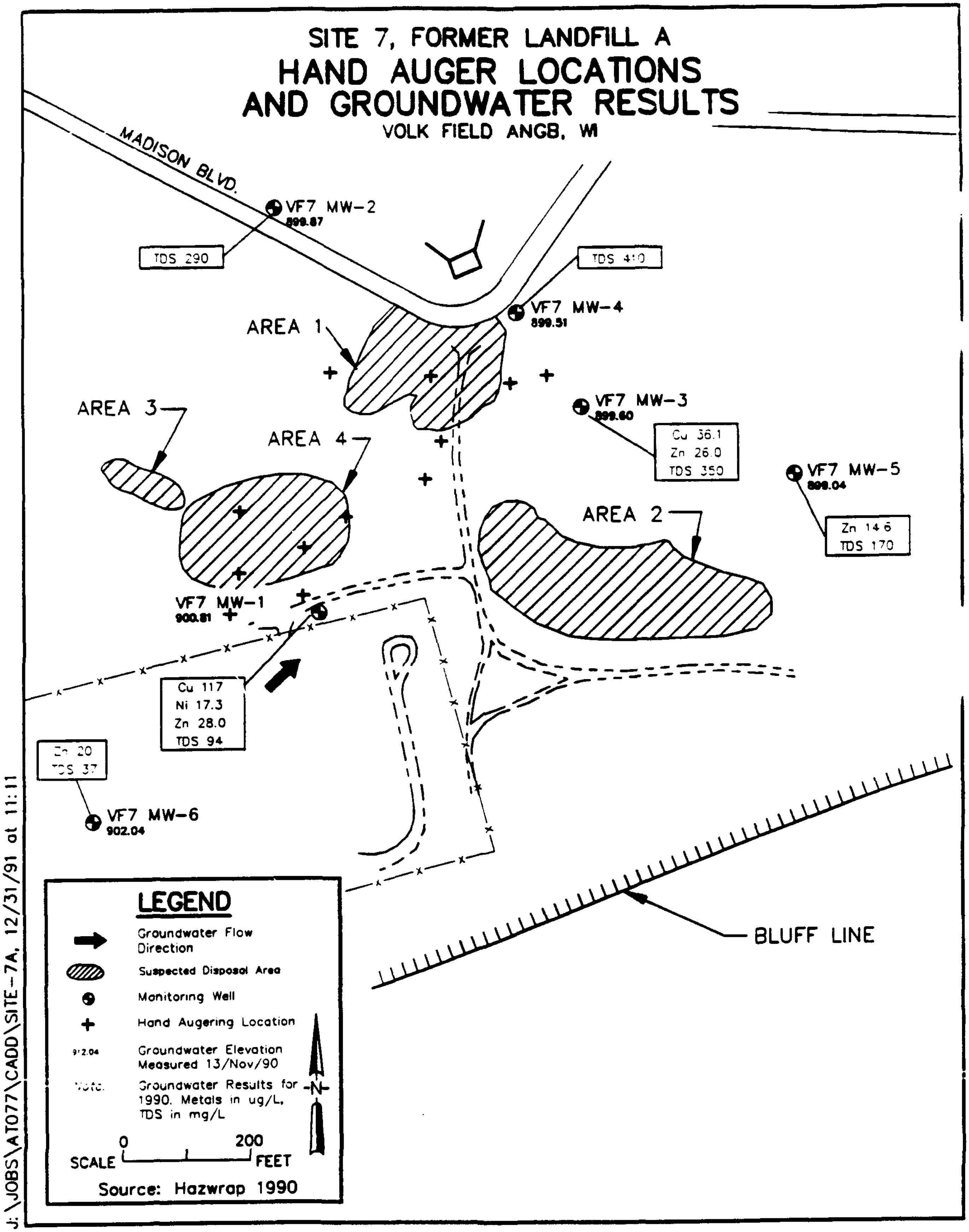

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TABLE 10.1
SITE 7, FORMER LANDFILL A
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameter	VF7-MW1	VF7-MW2	VF7-MW3	VF7-MW4	VF7-MW5	VF7-MW6	VF7-MW7(a)
Date Sampled	10/25/90	10/24/90	10/25/90	10/25/90	10/25/90	10/23/90	10/25/90
Halogenated Volatiles - SW8010 (ug/L)	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U	U	U	U	U	U
Organochlorine Pesticides & PCB's CLP SOW (ug/L)	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organics - CLP SOW (ug/L)	ND	ND	ND	ND	ND	ND	ND
13 Priority Pollutant Metals (ug/L)							
Copper	U	U	36.1	U	U	U	117
Nickel	U	U	U	U	U	U	17.3
Zinc	U	U	26.0	U	14.6	20.0	28.0
Total Dissolved Solids E160.1 (mg/L)	94	290	350	410	170	37	71

ND - No analytes detected for this method.
U - Below the detection limit.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
(a) - Duplicate of VF7-MW1.

TABLE 10.2
SITE 7, FORMER LANDFILL A
CHEMICALS OF CONCERN DETECTED IN GROUNDWATER
VOLK ANGB, CAMP DOUGLAS, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (a) (mg/L)
Copper (Dissolved)	0.0361–0.117	2 / 6	2.89E–02	4.10E–02	7.19E–02

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n–1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

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TABLE 10.3

SITE 7, FORMER LANDFILL A
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 7; areas downwind	Onsite workers, nearby residents	Inhalation	Unlikely. VOCs are unlikely to be present in soils. No VOCs were detected in groundwater.
	Contaminated soils/ fugitive dust generation	Site 7; areas downwind	Onsite workers, nearby residents	Inhalation	Unlikely. Vegetative cover will retard wind erosion.
Groundwater	Contaminated soils, waste/leaching to groundwater	Downgradient wells	Onsite workers, nearby residents	Oral, dermal, inhalation	Low. Low concentrations of inorganics were detected in downgradient monitoring wells. Groundwater ingestion exposures would be possible.
		Base supply well W4	Onsite workers	Oral, dermal, inhalation	None. No contaminants were detected in this well.
Surface Water	Contaminated groundwater, contaminated soils/ surface runoff, groundwater discharge	Lake near site	Recreational users of the lake	Oral, dermal, inhalation	Unlikely. Runoff is unlikely to reach the lake due to site topography, vegetation and sandy soils. No contaminants other than low levels of inorganics were detected in groundwater.
Soils	Contaminated soils/leaching, runoff, tracking	Site 7	Onsite workers	Oral, dermal	Unlikely. Landfill is inactive and is vegetated.

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TABLE 10.3–Continued

SITE 7, FORMER LANDFILL A
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 7; areas downwind	Onsite workers, future residents	Inhalation	Unlikely, but possible only if contaminants are present in soils which could be exposed during construction.
Groundwater	Contaminated soils/leaching to groundwater	Well onsite or downgradient	Onsite workers, future residents	Oral, dermal, inhalation	Low. Low concentrations of inorganics were detected in downgradient monitoring wells. Oral exposures would be possible.
Surface Water	Contaminated groundwater, contaminated soil/surface runoff, groundwater discharge	Lake near site	Recreational users of the lake	Oral, dermal, inhalation	Unlikely. Runoff is unlikely to reach the lake due to site topography, vegetation, and sandy soils. No contaminants other than low levels of inorganics were detected in groundwater.
Soils	Contaminated soils/runoff, tracking, leaching	Site 7	Future residents, onsite workers	Oral, dermal	Unlikely, but possible only if contamination is present in soils which could be exposed during construction activities. VOCs are unlikely to be present since they were not detected in groundwater. However, compounds which are neither soluble nor mobile could be present in soils and not be present in groundwater.

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TABLE 10.4
SITE 7, FORMER LANDFILL A
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF
GROUNDWATER BY CHILDREN (a)(b)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (c) (mg/l)	Intake Variable (d) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Copper	7.19E-02	1.28E-01	9.20E-03	ND	NA
				HAZARD INDEX =	0E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Because only metals were detected in groundwater and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(c) Concentration in groundwater represents the upper 95th percent confidence limit for the arithmetic mean.
(d) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 10.5
SITE 7, FORMER LANDFILL A
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY WORKERS (a)(b)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (c) (mg/l)	Intake Variable (d) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Copper	7.19E-02	9.78E-03	7.03E-04	ND	NA
				HAZARD INDEX =	0E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Because only metals were detected in groundwater and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(c) Concentration in groundwater represents the upper 95th percent confidence limit for the arithmetic mean.
(d) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 10.6
SITE 7, FORMER LANDFILL A
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)(b)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (c) (mg/l)	Intake Variable (d) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Copper	7.19E-02	2.74E-02	1.97E-03	ND	NA
				HAZARD INDEX =	0E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Because only metals were detected in groundwater and dermal absorption for metals = 0, no dermal exposure risk tables are given.
(c) Concentration in groundwater represents the upper 95th percent confidence limit for the arithmetic mean.
(d) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 10.7
CHEMICAL CONSTITUENTS DETECTED AT SITE 7
AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Groundwater (ug/L)					
Arsenic	1988	55(1)	MCL/WIDNR	50	Yes
Beryllium	1988	3(1)	--	--	--
Cadmium	1988	29(1)	MCL	5	Yes
Chromium (VI)	1988	100(1)	WIDNR	50	Yes
Copper	1988, 1990	117	WIDNR	1,000	No
Lead	1988	46(1)	MCL	15	Yes
Nickel	1988, 1990	70(1)	--	--	--
Silver	1988	30(1)	WIDNR	50	No
TDS	1988, 1990	438,000	--	--	--
Zinc	1988, 1990	180(1)	MCL/WIDNR	5,000	No

MCL - Safe Drinking Water Act Maximum Contaminant Level.

WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.

(1) - Unfiltered sample; detected concentration not used in risk assessment.

SECTION 11
SITE 8 - F84 CRASH SITE

BACKGROUND

Site 8-F84 Crash Site is located at the western end of the east-west runway (Figure 11.1). The crash occurred around 1964 and may have generated a release of about 400 gallons of JP-4 to the ground [HMTC, 1986]. In 1966, the paved portion of the east-west runway was extended 1,000 feet to the west, covering the reported crash site. It is likely that contaminated soils were excavated and removed from the area during the construction of the runway extension.

No field work was performed at this site during the 1987 and 1989 field investigations.

1990 Field Activities

The work performed at Site 8 included a records search, soil boring, monitoring well and piezometer installation and soil and groundwater sampling.

Before beginning any field work, ES personnel conducted a records search and interviewed Base personnel to determine the location of the crash as accurately as possible. As a result of these activities the locations for soil borings, piezometers and monitoring wells were selected as shown on Figure 11.1.

Two soil borings were advanced with hollow-stem augers to collect soil samples. Two soil samples were collected from each borehole, one from the ground surface and one from a depth just above the water table. The samples were analyzed for aromatic volatile organics, TPH and lead.

Three piezometers were installed with hollow-stem augers prior to installing one monitoring well. Two piezometers were installed north of the runway and one was installed on the south side of the runway. PZ-1 and PZ-3 were screened from 7.5 to 12.5 feet, while PZ-2 was screened from 10 to 15 feet. Local groundwater flow direction was determined using the piezometers and a downgradient location for monitoring well MW-1 was chosen. The well was also installed with hollow-stem augers and screened from 7.5 to 17.5 feet. Groundwater samples were collected from the monitoring well and analyzed for aromatic volatile organics, TPH, lead and TDS. The well, piezometer and boring locations were surveyed for horizontal location and elevation upon completion of drilling activities.

1991 Field Activities

A groundwater measurement was obtained from VF8 MW-1 on 30 October 1991. No other activities were conducted at Site 8 in 1991.

RESULTS

The results of the field efforts conducted at Site 8 are provided in this subsection.

Geology/Hydrogeology

Fine to medium sands interfingered with clay underlie Site 8 to a depth of at least 20 feet. The sands are yellowish brown in color and the clays are mostly brown and mottled with occasional black organic staining typical of Pleistocene deposits. Sandstone was not encountered in borings at this site. Soil boring and well construction logs are included in Appendix B.

The average depth to groundwater at this site is approximately 4 feet below the ground surface. Groundwater elevations measured on 13 November 1990 indicate local flow is to the north with an average horizontal gradient of 0.0274 ft/ft (Figure 11.1). Elevation data and well construction details are presented in Table 2.4 of the Environmental Setting (Section 2). A complete summary of the groundwater measurements is included in Appendix B.

Soil Sampling Results

Soil samples were collected at two depths in each of two soil borings, 0 to 2 feet and 4 to 6 feet. Each of the four samples was submitted to the laboratory for chemical analysis. Laboratory analytes were aromatic volatiles, TPH and lead. Lead was detected in every sample at levels ranging from 2.0 mg/kg to 7.8 mg/kg. Neither TPH nor aromatic volatiles were detected. A summary of these analytical results is presented on Table 11.1.

Groundwater Sampling Results

Monitoring well MW-1 was sampled twice during the RI. Both samples were analyzed for aromatic volatiles, TPH, dissolved lead and TDS. No contamination was found in either sample. TDS was found at 260 and 370 mg/L in the groundwater from the first and second sampling efforts, respectively. These results are presented in Table 11.2.

BASELINE RISK ASSESSMENT

The following subsections present the Site 8 baseline risk assessment including a human health evaluation and ecological evaluation. The risk assessment presented here was conducted according to the most recent EPA guidelines and includes site monitoring data from 1990 and 1991.

Selection of Chemicals of Concern

The baseline risk assessment procedures described in Section 4 were used to select chemicals of concern for Site 8. Lead was the only analyte detected in soils at the site and was retained as a chemical of concern. The arithmetic average, standard deviation, and maximum detected concentration for lead are given in Table 11.3. Toxicity information for lead is discussed in Section 4 and Appendix F. No chemicals were detected in groundwater; therefore, no chemicals of concern were selected for groundwater.

Human Health Evaluation

The following subsections present the Site 8 human health evaluation.

Exposure Pathways

Potential sources for contaminant release at this site include soils in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. The only potential exposure point considered for Site 8 is soils. Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g., ingestion, absorption, etc.).

Site 8 is located under the east-west runway and is heavily vegetated and is paved with concrete. Access is restricted to Base workers engaged in maintenance-related activities. Hypothetical (future) exposure pathways would include exposures to onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 8 are summarized in Table 11.4.

Soils. Current exposure pathways involving incidental ingestion of and dermal contact with soils at Site 8 are unlikely but possible for onsite workers. In the event that a residence was constructed at Site 8, both ingestion and dermal contact with soils by hypothetical residents could occur.

Groundwater. Contaminants were not detected in the monitoring well immediately downgradient of Site 8. Groundwater exposure pathways are thus not considered present at this site.

Surface Water. Site 8 lies within the Lemonweir River drainage basin. Marshy areas exist to the north and south of the site. The river is more than 2 miles away from the site and contamination in surface water runoff from the site is not expected to reach the river in detectable concentrations. The surface water pathway was not considered a major concern at Site 8, and surface water exposure pathways were not evaluated.

Air. Exposures via inhalation of lead released to air via wind erosion of the surface soils could occur. However, low risks are anticipated for air exposure pathways because the concentrations of contaminants in soils are minimal, and releases to air by wind erosion would also be mitigated by dispersion and degradation. Furthermore, releases of non-volatile chemicals, such as lead, through wind erosion would be controlled by the concrete and vegetative cover. Exposure to contaminants released to the air from soils were not quantified since the risks associated with this pathway would be orders of magnitude lower than those associated with oral and dermal exposure to soils.

In this assessment, exposure concentrations, exposure intakes (ingestion and dermal contact pathways only) and subsequent risks are presented in the following tables:

Exposure Pathway	Group Affected	Carcinogenic Table No.
Ingestion of soils	Children	11.5
	Workers	11.6
	Adult residents	11.7
Dermal contact with soils	Children	11.8
	Workers	11.9
	Adult residents	11.10

Risk Characterization

Carcinogenic Risks

Lead was the only carcinogenic compound detected in soils. Risks associated with exposure to lead cannot be calculated since there is no slope factor for lead. However, the lead concentrations detected in soils (2.0 to 7.8 mg/kg) were well below EPA's risk-based target concentration for lead in soil (500 mg/kg).

Ecological Evaluation

Site 8 is located under the east-west runway, which is bounded by grass. A marshy area exists to the north of the site. A marshy area and stands of jack pine, northern hardwoods, oak, red pine and aspen are located to the south of the site. Ecological receptors supported by these habitats are summarized in Section 4.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 8 could include the following:

- Ingestion and dermal contact with lead in soils, particularly for burrowing species of animals;
- Uptake of lead in soils by plants; and
- Inhalation of lead released from contaminated soils by terrestrial and avian species.

Inhalation of lead released via fugitive dust generation is unlikely since the site is both vegetated and paved. Oral and dermal exposures for animals and uptake by plants are similarly expected to be limited.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in soils. However, toxicity values are available to evaluate lead detected in soils associated with Site 8 and are presented in Table 4.10. These values include acute oral LD50s for mammals. It should be noted that these values can be used only in a qualitative way to screen for potential impacts and highlight the detected chemicals which might be toxic to mammals. There are no similar criteria for plants or birds.

Risk Characterization

A method of screening the relative toxicity of a chemical detected in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils. Lead is severely toxic to mammals and can also be toxic to plants when present in acidic soils.

Risk Assessment Conclusions

This subsection presents the conclusions and uncertainties of the baseline risk assessment.

Human Receptors

Lead was the only analyte detected in soils at Site 8. No compounds were detected in groundwater. Due to the proximity of the site to the east-west runway, the low level of contamination detected and the thick vegetative and concrete cover at the site, current human exposure at Site 8 is unlikely. The only current exposure pathways that could possibly occur are incidental ingestion of and dermal contact with soils by Base workers during runway maintenance. Hypothetical (future) human pathways which are possible if someone were to build a house at the site include ingestion of and dermal contact with contaminants in both surface and deep soils. Hypothetical (future) workers could also ingest and have dermal contact with

contaminants in surface and deep soils. An inhalation pathway associated with lead in soils is possible but was not calculated since risks associated with this pathway are likely to be orders of magnitude lower than those associated with the oral and dermal pathways.

It should be noted that any potential risks associated with lead in soils were not quantified in this assessment due to the lack of reference toxicity values for lead. However, the risks associated with lead at Site 8 are expected to be very low since the concentrations detected in soils are well below the EPA's target lead concentration (500 mg/kg) for lead in soils at Superfund sites [EPA, 1989b]. This EPA target concentration was based on multi-route exposure to lead-contaminated soils, given a blood lead level of concern of 10 to 15 μg/dl. A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4.

Ecological Receptors

Flora and fauna could be exposed through uptake of chemicals detected in soils. Burrowing animals are of particular concern, but exposures are expected to be limited.

It is not possible to characterize risks associated with lead detected at Site 8 due to the lack of approved reference toxicity information. However, toxicity values are available to qualitatively evaluate compounds detected in soils. Based on reference values for acute exposure, lead is severely toxic to mammals. It is not possible to predict whether the concentrations detected in soils are high enough to result in adverse effects. Since no groundwater contamination was detected, exposures via groundwater (plants) are not expected.

CONCLUSIONS AND RECOMMENDATIONS

Site 8 was investigated because of a reported fuel release resulting from a plane crash in the 1960s. Table 11.11 presents a summary of the compounds detected and a comparison to ARARs introduced in Table 4.1 through 4.4. Soils and groundwater at the site were investigated and only lead in soils was found. No ARARs were identified for soils, however, To-Be-Considered criteria are presented in Section 4. Carcinogenic risks associated with exposure to lead cannot be calculated because there is no slope factor for lead. Because the lead concentrations detected in soils were well below EPA's risk-based target concentration, risks associated with lead are expected to be well below EPA's target risk range. Therefore, it is concluded that no unacceptable risks are associated with this site, and a No-Further-Action Decision Document should be prepared for Site 8.

Figure 11.1

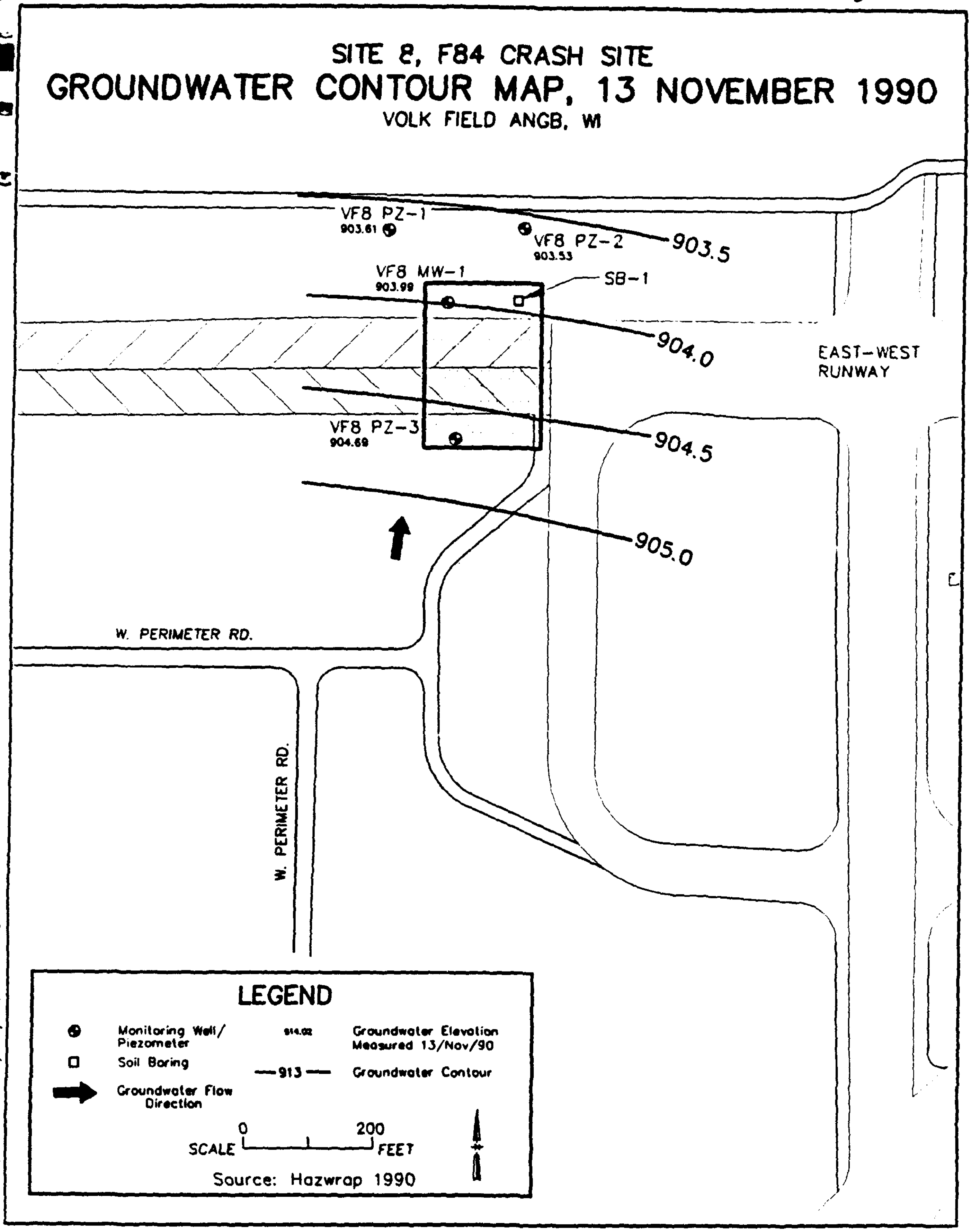
SITE 8, F84 CRASH SITE
GROUNDWATER CONTOUR MAP, 13 NOVEMBER 1990
VOLK FIELD ANGB, WI
VF8 PZ-1
903.61
VF8 PZ-2
903.53
903.5
VF8 MW-1
903.99
SB-1
904.0
EAST-WEST
RUNWAY
VF8 PZ-3
904.69
904.5
905.0
W. PERIMETER RD.
W. PERIMETER RD.
LEGEND
Monitoring Well/
Piezometer
Groundwater Elevation
Measured 13/Nov/90
Soil Boring
913
Groundwater Contour
Groundwater Flow
Direction
0
200
SCALE
FEET
Source: Hazwrap 1990

TABLE 11.1
SITE 8, F84 CRASH SITE
DETECTED ANALYTES IN SOIL SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF8-SB1 (0'-2')	VF8-SB1 (4'-6')	VF8-SB2 (0'-2')	VF8-SB2 (4'-6')
Date Sampled	09/30/90	09/30/90	09/30/90	09/30/90
Aromatic Volatiles - SW8020 (ug/kg)	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U	U	U
Lead - SW7421 (mg/kg)	3.8	2.0	7.8	6.8

ND - No analytes detected for this method.
U - Below the detection limit.

TABLE 11.2
SITE 8, F84 CRASH SITE
DETECTED ANALYTES IN
GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF8-MW1	VF8-MW1
Date Sampled	10/23/90	11/06/90
Aromatic Volatiles - SW8020 (ug/L)	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U
Dissolved Lead - SW7421 (ug/L)	U	U
Total Dissolved Solids - E160.1 (mg/L)	260	370

ND - No analytes detected for this method.
U - Below the detection limit.

TABLE 11.3
SITE 8, F84 CRASH SITE
CHEMICALS OF CONCERN DETECTED IN SOILS
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentrations (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Maximum Detected Concentration (a) (mg/kg)
Lead	2.0-7.8	4 / 4	5.10E+00	2.32E+00	7.80E+00

(a) Sample size is less than 5 (n < 5), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 11.4

SITE 8, F84 CRASH SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/ fugitive dust generation	Site 8; areas downwind	Onsite workers, nearby residents	Inhalation	Very low. Low levels of lead were detected in soils, and the site is heavily vegetated and receptors are only present occasionally.
Groundwater	Contaminated soils/leaching to groundwater	Downgradient wells	Onsite workers, nearby residents	Oral, dermal, inhalation	None. No contamination was detected in the monitoring well.
Surface Water	Contaminated soils/ surface runoff	Lemonwier River	Onsite workers, nearby residents	Oral, dermal, inhalation	Unlikely. There are low levels of lead detected in soils, a lack of surface water at the site, and a large distance to the river (>2 miles).
Soils	Contaminated soils/leaching, runoff, tracking	Site 8	Onsite workers	Oral, dermal	Low. Low levels of lead were detected, but the site is heavily vegetated and receptors are not frequently present.
FUTURE USE SCENARIOS					
Air	Contaminated soils/ fugitive dust generation	Site 8; areas downwind	Future residents, onsite workers	Inhalation	Very low. Lead concentrations are well below EPA's risk-based cleanup target of 500 ppm.
Groundwater	Contaminated soils/leaching to groundwater	Wells onsite or downgradient	Future residents, onsite workers	Oral, dermal, inhalation	None. No groundwater contamination was detected.

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TABLE 11.4-Continued

SITE 8, F84 CRASH SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS (Cont'd)					
Surface Water	Contaminated soil/ surface runoff	Lemonwier River	Future residents	Oral, dermal, inhalation	Unlikely. There are low levels of lead detected in soils, a lack of surface water at the site, and a large distance to the river (>2 miles).
Soils	Contaminated soils/leaching, runoff, tracking	Site 8	Future residents, onsite workers	Oral, dermal	Low. Low levels of lead detected in soils. It is unlikely that homes would be developed here unless the airfield ceases to be used.

TABLE 11.5
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
SOILS BY CHILDREN
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	1.10E-06	8.58E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 11.6
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF
SOILS BY WORKERS
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	3.49E-07	2.72E-06	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 11.7
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR INGESTION OF SOILS BY ADULT RESIDENTS
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	5.87E-07	4.58E-06	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 11.8
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SOILS BY CHILDREN
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (c) 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are adjusted for dermal absorption.
(c) Oral value is used: assumes 100% oral absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 11.9
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SOILS BY WORKERS
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (c) 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are adjusted for dermal absorption.
(c) Oral value is used: assumes 100% oral absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 11.10
SITE 8, F84 CRASH SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SOILS BY ADULT RESIDENTS
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (c) 1/(mg/kg/day)	Chemical-Specific Risk
Lead	7.80E+00	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		0E+00

(a) Concentration in soil represents the maximum detected concentration.
(b) Intake variables are adjusted for dermal absorption.
(c) Oral value is used: assumes 100% oral absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 11.11
CHEMICAL CONSTITUENTS DETECTED AT SITE 8 AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Lead	1990	7.8	--	--	--
Groundwater (ug/L)					
TDS	1990	370,000	--	--	--

MCL - Safe Water Drinking Act Maximum Contaminant Level.

SECTION 12
SITE 9 - FORMER LANDFILL B

BACKGROUND

This subsection provides a brief description and history of Site 9 including a summary of the field activities performed at this site.

Site Description

Site 9 is an abandoned landfill located south of the unimproved access road directly south of the fire training area (Site 1) and due east of Bluff Road. The location of Site 9 is shown on Figure 12.1. A sandstone bluff is immediately to the south and west of this site. The exact location of the landfill is not evident from any surface features in this area. However, a geophysical investigation was accomplished during the SI and the approximate location of the landfill was determined. A slight depression is present adjacent to the area where material is believed to have been disposed.

Site History

Materials buried prior to the closing of the landfill may have included general refuse, lead, ammunition and a C-47 aircraft [HMTC, 1984]. There is also a possibility that the discharge of fuels occurred at Site 9. Portions of the fuels reportedly released at Site 1 resulted from the maintenance of refueling vehicles [HMTC]. Base personnel reported refueling was not limited to the fire training pit but occurred at various locations along both sides of the unimproved access roads in this area, perhaps at Site 9. A 1965 aerial photograph indicated other access roads existed at different locations in this area. Some of these historic access roads are included on Figure 5.1, which was presented for Site 1 in Section 5. Base personnel informed ES that an aircraft was believed to be buried immediately south of the unimproved access road at Site 9. As discussed in Section 5, a potential source of fuel contamination may be the burning of munitions in this area as reported by Base personnel.

1987 Field Activities

The SI conducted in 1987 included a geophysical survey and the installation of three monitoring wells, MW-1 through MW-3 (Figure 12.1). The results of the samples collected from these wells indicated BETX was present at very low levels in MW-3 [ES, 1990c]. This data is summarized in Appendix G.

1989 Field Activities

Geophysical surveys were conducted over this site in conjunction with the geophysical surveys at Site 1, primarily to locate possible buried munitions. This is discussed in Section 5. Groundwater elevations were measured three times during 1989 at each of the three previously installed monitoring wells.

1990 Field Activities

Work performed in 1990 included soil and groundwater sampling for chemical analysis, water level measurements and surveying of soil sampling locations. Three surficial soil samples were obtained from the locations depicted on Figure 12.1. These samples were analyzed for halogenated and aromatic volatile organics, pesticides and PCBs, semivolatiles and metals.

Groundwater samples were obtained from each monitoring well. The samples were analyzed for halogenated and aromatic volatile organics, pesticides and PCBs, semivolatiles, TPH, metals and TDS. In addition, water level measurements were obtained from all monitoring wells at Site 9 on two occasions in 1990.

1991 Field Activities

Groundwater elevations in all of the monitoring wells at Site 9 were measured on 30 October 1991. No other activities were conducted at Site 9 in 1991.

RESULTS

The results of the 1990 field investigation are provided in this subsection. The results of the geophysical survey conducted at Site 9 during 1989 were previously discussed in Section 5 - Site 1, Fire Training Area. The geophysical survey results are presented in Appendix C.

Geology/Hydrogeology

Monitoring well logs indicate Site 9 is underlain by mostly fine, brownish-orange sand to an average depth of 12 feet. This sand overlies a weathered, orange, fine-grained sandstone which persisted to the maximum boring depth of 33.5 feet (1987 boring) [ES, 1990c].

The average depth to groundwater is approximately 16 feet below ground surface. Groundwater measurements from wells at both Sites 1 and 9 were used to determine gradients. Figure 12.1 was prepared according to groundwater elevations measured on November 13, 1990. Groundwater flow is to the north-northeast with an average horizontal gradient of 0.006 ft/ft. Elevation data are presented in Table 2.4 of the Environmental Setting (Section 2); a complete summary of groundwater measurements is provided in Appendix B.

The groundwater flow velocity at this site is estimated to be 2.9 ft/day. This is based upon a hydraulic conductivity of 725 gpd/ft^2 or 97 ft/day (estimated from a

1988 aquifer pumping test) [ES, 1990b, 1990c], the hydraulic gradient and a porosity of 0.2 [Bouwer, 1978].

Soil Sampling Results

The results of soil sampling at Site 9 in 1990 are presented in Table 12.1. Volatile organics were not detected in any of the three surface soil samples collected at this site. Several semivolatiles and pesticides were detected in the sample collected from SB-2. DDT was detected at 0.287 mg/kg and a concentration of its breakdown component, DDD, was estimated at 0.037 mg/kg. The five semivolatiles detected are considered polycyclic aromatic hydrocarbons. These PAHs were detected at estimated concentrations ranging from 0.210 to 0.360 mg/kg. ARARs for PAHs in soils do not exist. Chromium, copper, nickel, zinc, mercury and lead were detected in all three surficial soil samples. The metals concentrations detected in samples from Site 9 are consistent with background concentrations presented in Table 4.5 in Section 4. No guidance criteria are exceeded for any of the compounds detected in the soils at Site 9.

Groundwater Sampling Results

Samples collected in 1990 from the three monitoring wells contained dissolved cadmium and zinc at low concentrations in one sample. TDS ranged from 33 to 88 mg/L. Halogenated volatiles, aromatic volatiles, TPH, semivolatiles and pesticides/PCBs were not detected in Site 9 groundwater samples. Table 12.2 summarizes these analytical results.

Low levels of BETX were detected at monitoring well MW-3 in 1988. These levels were very near detection limits. BETX were not detected in 1990, possibly due to the degradation of BETX to below detection limits. The metals data obtained in 1988 were from unfiltered samples and are not directly comparable to the results obtained in 1990.

BASELINE RISK ASSESSMENT

The following subsections present the Site 9 baseline risk assessment. The section is divided into a human health evaluation, ecological evaluation, and conclusions for the baseline risk assessment. Analytical results for groundwater samples from the 1988 SI (ES, 1990c) were used along with the 1990 analytical results in the preparation of this baseline risk assessment. An exception is the unfiltered metals data mentioned above. The 1988 data is presented in Appendix G.

The risk assessment presented here was conducted according to the most recent EPA guidelines. These risk assessment procedures are outlined in Section 4. The available toxicity information for the chemicals detected at this site is presented in Section 4 and Appendix F.

Selection of Chemicals of Concern

Metals, VOCs and semivolatile organic compounds (e.g. DDT/DDD and PAHs) were detected at Site 9. The chemicals of concern selected for each medium are presented and discussed in the subsections below.

Surface Soils

DDD, DDT, PAHs (i.e., benzo(b)fluoranthene, chrysene, phenanthrene, pyrene, and fluoranthene), chromium, copper, nickel, zinc, mercury and lead were detected in the three surface soil samples collected from this site as indicated in Table 12.1. Two metals (nickel and mercury) were eliminated because the detected concentrations of these metals did not exceed three times the respective minimum background concentrations (Table 4.5). The remainder of the chemicals detected in site soils were selected as chemicals of concern at Site 9. These chemicals, along with the arithmetic average, standard deviation, and maximum detected concentrations are presented in Table 12.3. Because the number of samples analyzed for these chemicals was less than five, the maximum detected concentrations (and not the 95 percent UCL of the arithmetic means) are presented in Table 12.3. These maximum detected concentrations were then used in estimating exposures.

Groundwater

Only filtered sample results were used to establish chemicals of concern for groundwater at this site. Dissolved cadmium and zinc and VOCs (benzene, ethylbenzene, toluene, and xylenes) were detected in groundwater samples collected from this site in 1987 and 1990. These chemicals were selected as chemicals of concern and are presented in Table 12.4 along with the arithmetic average, standard deviation and maximum detected concentrations. Because the number of samples analyzed for these chemicals was less than five, the maximum detected concentrations (and not the 95 percent UCL of the arithmetic means) are presented in Table 12.4. These maximum detected concentrations were then used in estimating exposures.

Human Health Evaluation

The human health evaluation is presented in the following subsections.

Exposure Pathways

Potential sources for contaminant release at this site include the fuels or other waste materials disposed at the site and any soils or groundwater in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 9 are soils at the site (both on the surface and at depth) and groundwater at and downgradient of the site.

Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point. The grounds are maintained, dumpsters are stored in this area, and trucks routinely drive through the area. The site is centrally located on the Base and access by personnel not living or working on the Base is therefore limited; however, access to Site 9 is not controlled by fencing.

Based upon this site setting, children who currently live more than a mile northeast of the site are unlikely to wander onto the Base and should not therefore be exposed at Site 9; however, onsite Base workers could be exposed during work activities at the site. Hypothetical (future) exposure pathways would include exposures to: onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 9 are summarized in Table 12.5.

Soils. The landfill is now vegetated, therefore, current pathways involving incidental ingestion of and dermal contact with soils at Site 9 are unlikely but possible for onsite workers. In the event that a residence were constructed at Site 9, both oral and dermal contact with soils by hypothetical residents would be more likely to occur.

Groundwater. Private water supply wells exist downgradient (northeast) of Site 9. Wells from six residences northeast of the Base were sampled for VOCs in 1984 and found to be clean [Endres and Engler, 1984]. Base production wells are also present downgradient of Site 9 (Figure 2.7). Base production well BPW-4 and the Base boundary well VF92 MW-1 (Figure 2.6) were sampled for the full spectrum of organic and inorganic contaminants and found to be clean. Given these considerations, it is improbable that downgradient water supply wells are currently contaminated. However, chemicals were detected in monitoring wells immediately downgradient of the site and contamination of future downgradient supply wells is possible. Exposure could occur via ingestion of groundwater, dermal contact with groundwater during showering and inhalation of VOCs released from groundwater during showering. The oral pathways would apply to future employees as well as residents. The dermal and inhalation pathways would apply to future residents who might shower or bathe with the contaminated groundwater.

Surface Water. Site 9 lies within the Lemonwier River drainage basin, but surface water flows on or near the site only during rainfall events. The river is more than 2 miles away from the site and contamination in surface water runoff from the site is not expected to reach the river at detectable concentrations. Migration of contaminants to the river from the site via groundwater discharge is also possible, but given the low concentrations and nature of the contaminants present in groundwater, as well as the distance from the site to the river, groundwater

discharge is not expected to contribute detectable contamination to the river. The surface water pathway was not considered a major concern at Site 9, and surface water pathways were not evaluated further.

Air. VOCs were detected in soil samples taken from Site 9 and it is possible that exposure could occur via inhalation of these compounds released to the air. However, exposures to contaminants released to the air from soils were not quantified since the risks associated with this pathway would be orders of magnitude lower than those associated with oral and dermal exposure to soils. Low risks are anticipated for air exposure pathways because the concentrations of contaminants in soils are minimal. Releases to air by volatilization or wind erosion would also be mitigated by dispersion and degradative processes. Furthermore, releases of chemical compounds with low or no volatility, such as lead, through wind erosion would be controlled by the soil and vegetative cover present at the site.

In this human health evaluation, risks and hazard indices were calculated for the following pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of surface soils	Children	12.6	12.7
	Workers	12.8	12.9
	Adult residents	12.10	12.11
Dermal contact with surface soils	Children	12.12	12.13
	Workers	12.14	12.15
	Adult residents	12.16	12.17
Ingestion of groundwater	Children	12.18	12.19
	Workers	12.20	12.21
	Adult residents	12.22	12.23
Dermal contact with groundwater(1)	Children	12.24	12.25
	Adult residents	12.26	12.27
Inhalation of VOCS(1)	Children	12.28	12.29
	Adult residents	12.30	12.31

(1) Workers were not considered to be exposed to contaminants in groundwater via showering (dermal and inhalation) because showering is assumed to take place at their homes.

Risk Characterization

Carcinogenic Risks

A summary of the carcinogenic risks for each receptor is provided in Table 12.32. The calculated risks for each environmental medium and exposure pathway are discussed below.

Soils. Carcinogenic risks for all soil exposure pathways and receptors were below EPA's target risk range of one-in-one million (1E-06) to one-in-ten thousand (1E-04). Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated carcinogenic risks for soil pathways at Site 9 do not indicate unacceptable health risks are currently present or will occur in the future.

Groundwater. Carcinogenic risks were evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from the groundwater during showering. The carcinogenic risks were within EPA's acceptable risk range (1E-06 to 1E-04) for these three groundwater exposure pathways and the potential receptors assessed (onsite workers and adults/children residing on the site). Thus, the calculated carcinogenic risks for potential (future) groundwater exposures do not indicate unacceptable risks.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was also assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 12.33. A hazard index which exceeds 1 is an indication that adverse health effects are likely. The hazard index for each environmental medium and exposure pathway are discussed below.

Soils. The hazard indices for all soil exposure pathways and receptors were less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated hazard indices for soil pathways at Site 9 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Groundwater. Noncarcinogenic health hazards were also evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from groundwater during showering.

(1) Ingestion. The hazard index for children ingesting site groundwater (3) exceeds 1 and indicates that adverse health effects would occur if the hypothetical (future) exposure did, in fact, occur. The chemical contaminant contributing the major portion of this index was cadmium. The hazard indices for adults and onsite workers did not exceed 1 and therefore a potential health hazard should not exist for these groups of hypothetical (future) receptors.

(2) Dermal Absorption and Inhalation of VOCs. Dermal absorption and inhalation were evaluated for hypothetical (future) site residents (adults and children) and the calculated hazard indices for these potential receptors were much less than 1. Thus, these exposure routes/pathways do not represent a health hazard, even with the conservative residential assumptions used in the assessment.

Ecological Evaluation

Site 9 is classified as a grassland. A stand of northern hardwoods and jack pine is directly north of the site. Stands of oak, northern hardwoods, and aspen occurred to the northeast of the site next to Site 7. Cover types consisting of northern hardwood, red pine, mixed conifer, marsh, grassland, lowland brush, white pine, and bottom hardwoods occur on the Base south of Site 9. Ecological receptors supported by these habitats are summarized in Section 4.

Exposure Assessment

Primary exposure pathway for ecological receptors at Site 9 could include:

- ingestion and dermal contact with contaminants in soils by animals, particularly burrowing species;
- uptake of contaminants in soils by plants;
- uptake of contaminants in groundwater by plants;
- ingestion of contaminated plants or animals; and
- inhalation of VOCs released from contaminated soils by terrestrial and avian species.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is vegetated. No VOCs were detected in soils, thus no inhalation exposures resulting from VOC release from soils are expected.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposures of flora and fauna to chemicals in groundwater or soils. However, toxicity values are available to evaluate compounds detected in the soils associated with Site 9 and are presented in Table 4.10. These values include acute oral LD50s for mammals. It should be noted that these values can be used only in a qualitative way to screen for potential impacts. Acute LD50 values can only be used to highlight the detected chemicals that might be toxic to mammals. There are no similar criteria for plants or birds.

Risk Characterization

Lead can be toxic to terrestrial plants in acidic soils. When soil pH is neutral or alkaline, lead is found in forms which are unavailable for uptake by plants.

There are no toxicity values with which to evaluate exposures of fauna to chemicals in groundwater. However, method of screening the relative toxicity of a chemical detected in soils is by reviewing the lowest mammalian LD50s for that compound and ranking it as described in Section 4. This review was done for each chemical of concern for site soils. Lead and chromium were the only compounds detected in surface soils which are severely toxic to mammals. Pyrene, DDT, copper and zinc, which are classified as moderately toxic, were also detected. All other chemicals detected in soils at Site 9 are classified as slightly toxic or very slightly toxic with respect to acute oral toxicity.

DDT is known to be toxic to avian species. DDT and its associated metabolites are known to cause adverse chronic effects on successful egg-laying and incubation in bald eagles and other birds of prey (raptors). DDT biomagnifies through the food chain and results in the suppression of calcium metabolism and its role in eggshell production. A more complete discussion of DDT and its degradation products is presented in Section 6.

It is not possible to determine whether the concentrations of DDT in soils are high enough to result in adverse effects. However, based on the relative immobility of DDT in soil, the low concentrations of DDT in the soil and the distance between contaminated areas and aquatic areas that have a forage base for bald eagles, the risk to bald eagles from DDT at Site 9 appears low.

Risk Assessment Conclusions

Human Receptors

Volatile, semivolatile, and inorganic contaminants were detected in surface soils and groundwater at Site 9. The only current human exposure pathways which could possibly occur are incidental ingestion of and dermal contact with surface soils by onsite workers. Hypothetical (future) pathways which are possible if someone were to build a house at the site include ingestion of and dermal contact with contaminants in groundwater, ingestion of and dermal contact with contaminants in surface soils, and inhalation of VOCs released from groundwater during showering. Inhalation of VOCs and lead in surface soils are possible but were not quantified since the risks associated with these pathways are expected to be orders of magnitude lower than those associated with the oral and dermal pathways. The only unacceptable health risk determined for Site 9 is the noncarcinogenic hazard to hypothetical (future) children from groundwater ingestion at the site.

It should be noted that any potential human health risks associated with lead in soils are not quantified in this assessment due to the lack of reference toxicity values. The risks associated with lead at Site 9 are expected to be very low since the concentrations detected in soils are well below EPA's target lead concentration (500 mg/kg) for lead in soils at Superfund sites [EPA, 1989b]. This target concentration was based on multi-route exposure to lead contaminated soils, given a blood lead

level of concern of 10 to 15 μg/dl. The risks associated with the PAHs are not presently quantifiable.

A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4. An important assumption made in this risk assessment is that contaminant concentrations will remain constant and not decrease over a long period of time, up to 30 years. However, organic compounds, especially benzene, detected in both soils and groundwater do degrade with time. This would result in an overall decrease in contaminant concentrations.

Ecological Receptors

Flora and fauna could be impacted by uptake of chemicals detected in soils and groundwater. It is not possible to characterize risks for ecological receptors which are associated with contaminants detected at Site 9 due to the lack of approved reference toxicity information. However, toxicity values are available to qualitatively evaluate compounds detected in soils. Based on reference values for acute exposure, lead is the only compound in soils which is toxic to mammals. DDT, which is classified as moderately toxic was also detected. DDT and its degradation products, DDD and DDE, are known to be toxic to avian species. However, as discussed above the risk to bald eagles from DDT at Site 9 appears low.

CONCLUSIONS AND RECOMMENDATIONS

The Site 9 landfill exists beneath a grassy field located to the southwest of the main burn pit at Site 1. As discussed in Section 5, a geophysical survey did detect magnetic and electromagnetic anomalies southwest of the Site 1 main burn pit. These anomalies may identify the location of buried metals at Site 9.

Although materials may have been disposed of at this site, surface evidence of the landfill does not exist. Pesticides and PAHs were detected in one of the three soil samples. BETX were detected in groundwater at Site 9 during the SI [ES, 1990c]. Groundwater samples collected during this investigation contained only dissolved metals.

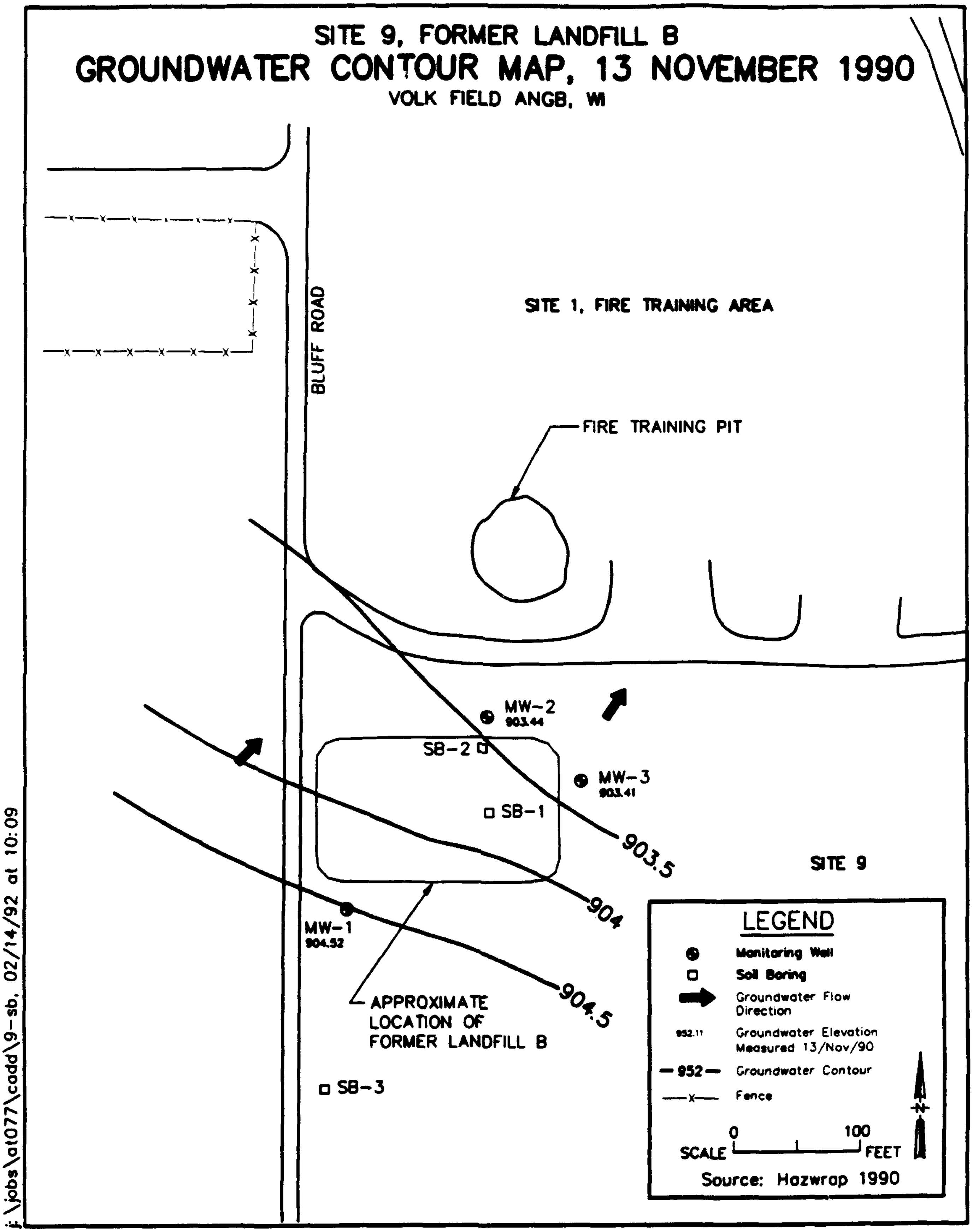
The compounds detected in soils and groundwater at Site 9, including those detected during the 1988 sampling effort [ES, 1990c], are presented in Table 12.34. This table also provides a comparison of the maximum detected concentrations to ARARs introduced in Table 4.1 through 4.4. ARARs exceeded at this site include the Wisconsin Enforcement Standard and the Federal MCL. ARARs for soils were not identified; however, To-Be-Considered criteria for soils are presented in Section 4. Compounds detected in groundwater which exceeded ARARs include cadmium and silver. Cadmium was detected in only one filtered groundwater sample while silver was detected in only one unfiltered groundwater sample.

The pathways for exposure considered at Site 9 included the incidental ingestion of and dermal contact with surface soils, ingestion and dermal contact with

groundwater, and inhalation of volatiles from groundwater. The risk assessment performed for Site 9 indicated the only unacceptable health risk is due to the noncarcinogenic hazard to hypothetical (future) children from groundwater ingestion at the site. This risk was caused by the presence of cadmium. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

Considering that the risk associated with cadmium is for a currently incomplete pathway it is recommended the wells at this site be sampled two times over the next year to monitor for the presence of cadmium. The results obtained from this sampling should be evaluated using the risk assessment procedures presented in this document. If significant levels of cadmium are not detected a No-Further-Action Decision Document should be prepared for Site 9.

Figure 12.1



SITE 9, FORMER LANDFILL B
GROUNDWATER CONTOUR MAP, 13 NOVEMBER 1990
VOLK FIELD ANGB, WI
BLUFF ROAD
SITE 1, FIRE TRAINING AREA
FIRE TRAINING PIT
MW-2
903.44
MW-3
903.41
SB-2
SB-1
903.5
SITE 9
904
MW-1
904.52
904.5
APPROXIMATE
LOCATION OF
FORMER LANDFILL B
SB-3
LEGEND
Monitoring Well
Soil Boring
Groundwater Flow Direction
952.11
Groundwater Elevation Measured 13/Nov/90
952
Groundwater Contour
Fence
0
100
SCALE
FEET
N
Source: Hazwrap 1990
i:\jobs\at077\cadd\9-sb, 02/14/92 at 10:09

TABLE 12.1
SITE 9, FORMER LANDFILL B
DETECTED ANALYTES IN SOIL SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF9-SB1 (0'-1')*	VF9-SB2 (0'-1')*	VF9-SB3 (0'-1')*
Date Sampled	10/29/90	10/29/90	10/29/90
Halogenated Volatiles - SW8010 (ug/kg)	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/kg)	ND	ND	ND
Organochlorine Pesticides & PCB's			
CLP SOW (ug/kg)			
4,4'-DDD	U	37J	U
4,4'-DDT	U	287	U
Semivolatile Organics - CLP SOW (ug/kg)			
Benzo(B)fluoranthene	U	250J	U
Chrysene	U	210J	U
Phenanthrene	U	210J	U
Pyrene	U	320J	U
Fluoranthene	U	360	U
13 Priority Pollutant Metals (mg/kg)			
Chromium	2.5	4.1	2.7
Copper	3.6	4.2	2.5
Nickel	2.4	2.6	1.9
Zinc	6.2	22.3	13.1
Mercury	0.0099	0.021	0.013
Lead	3.3	13	3.9

ND - No analytes detected for this method.
U - Below the detection limit.
J - Estimation below the detection limit.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
* Incorrectly labeled as 1-2' on the chain-of-custody.

TABLE 12.2
SITE 9, FORMER LANDFILL B
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameters	VF9-MW1	VF9-MW2	VF9-MW3
Date Sampled	10/24/90	10/26/90	10/26/90
Halogenated Volatiles - SW8010 (ug/L)	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U	U
Organochlorine Pesticides & PCB's CLP SOW (ug/L)	ND	ND	ND
Semivolatile Organics - CLP SOW (ug/L)	ND	ND	ND
13 Priority Pollutant Metals (ug/L)			
Cadmium	U	U	10.2
Zinc	U	U	30.8
Total Dissolved Solids - E160.1 (mg/L)	88	68	33

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.

TABLE 12.3
SITE 9, FORMER LANDFILL B
CHEMICALS OF CONCERN DETECTED IN SURFACE SOILS (TOP 2 FEET)
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/kg)	Detection Frequency	Arithmetic Average Concentration (mg/kg)	Standard Deviation (mg/kg)	Maximum Detected Concentration (a) (mg/kg)
Benzo(b)fluoranthene	0.250	1 / 2	2.08E-01	4.25E-02	2.50E-01
Chromium (VI)	2.5-4.1	2 / 2	3.30E+00	8.00E-01	4.10E+00
Chrysene	0.210	1 / 2	1.88E-01	2.25E-02	2.10E-01
Copper	3.6-4.2	2 / 2	3.90E+00	3.00E-01	4.20E+00
DDD	0.037	1 / 2	2.25E-02	1.45E-02	3.70E-02
DDT	0.287	1 / 2	1.48E-01	1.39E-01	2.87E-01
Fluoranthene	0.360	1 / 2	2.63E-01	9.75E-02	3.60E-01
Lead	3.3-13	2 / 2	8.15E+00	4.85E+00	1.30E+01
Phenanthrene	0.210	1 / 2	1.88E-01	2.25E-02	2.10E-01
Pyrene	0.320	1 / 2	2.43E-01	7.75E-02	3.20E-01
Zinc	6.2-22.3	2 / 2	1.43E+01	8.05E+00	2.23E+01

(a) Sample size is less than 5 ($n < 5$), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 12.4
SITE 9, FORMER LANDFILL B
CHEMICALS OF CONCERN DETECTED IN GROUNDWATER
VOLK ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	Maximum Detected Concentration (a) (mg/L)
Benzene	0.019	1 / 4	6.65E-04	7.19E-04	1.90E-03
Cadmium	0.0102	1 / 2	6.35E-03	3.85E-03	1.02E-02
Ethylbenzene	0.0021	1 / 4	8.00E-04	7.68E-04	2.10E-03
Toluene	0.0008	1 / 4	4.25E-04	2.49E-04	8.00E-04
Xylene	0.0071	1 / 4	2.08E-03	2.90E-03	7.10E-03
Zinc (Dissolved)	0.0308	1 / 2	1.79E-02	1.29E-02	3.08E-02

(a) Sample size is less than 5 ($n < 5$), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 12.5

SITE 9, FORMER LANDFILL B
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization	Site 9; areas downwind	Onsite workers, nearby residents	Inhalation	None. No VOCs were detected in soils.
	Contaminated surface soils/ fugitive dust generation	Site 9; areas downwind	Onsite workers, nearby residents	Inhalation	Unlikely. Low concentrations of semi-volatiles were detected in surface soil samples. Vegetation will retard erosion.
Groundwater	Contaminated soils/leaching to the groundwater	Downgradient wells	*Nearby residents*	Oral, dermal, inhalation	None. No VOCs were detected in 6 residential wells sampled in 1984. Analytes were not detected in the Base boundary well. However, contaminants were detected in wells downgradient of Site 9.
		Base supply wells W3 and W4	Onsite workers	Oral, dermal, inhalation	None. No contaminants were detected in these wells.
Surface Water	Contaminated soils, groundwater/ surface runoff, groundwater seepage	Lemonwier River	Nearby residents	Oral, dermal, inhalation	None. The site is flat and the river is greater than 2 miles away. The are no drinking water intakes on the river.
Soils	Contaminated soils groundwater/ leaching, runoff, tracking	Site 9	Onsite workers, nearby residents	Oral, dermal	Unlikely. Low levels of contaminants were detected in surface soils, and the landfill is inactive and vegetated.

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TABLE 12.5--Continued

SITE 9, FORMER LANDFILL B
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS					
Air	Contaminated soils/fugitive dust generation	Site 9; areas downwind	Future residents, onsite workers	Inhalation	Unlikely. VOCs were not detected in soils and the site is vegetated.
Groundwater	Contaminated soils/leaching	Wells onsite or downgradient	Future residents, onsite workers	Oral, dermal, inhalation	Low. Groundwater contamination was detected but at low concentrations in wells near site.
Surface Water	Contaminated soil, groundwater/ surface runoff, groundwater seepage	Lemonwier river	Nearby residents	Oral, dermal, inhalation	None. The site is flat and the river is greater than 2 miles away. There are no drinking water intakes on the river.
Soils	Contaminated soil, groundwater/ surface runoff, groundwater seepage	Site 9	Future residents, onsite workers	Oral, dermal	Low. Contamination was detected in soils.

TABLE 12.6
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	1.10E-06	2.75E-07	1.15E+01	3.16E-06
Chrysene	2.10E-01	1.10E-06	2.31E-07	1.15E+01	2.66E-06
DDD	3.70E-02	1.10E-06	4.07E-08	2.40E-01	9.77E-09
DDT	2.87E-01	1.10E-06	3.16E-07	3.40E-01	1.07E-07
Lead	1.30E+01	1.10E-06	1.43E-05	ND	NA
			CARCINOGENIC RISK =		6E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.7
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	1.28E-05	3.20E-06	ND	NA
Chromium (d)	4.10E+00	1.28E-05	5.25E-05	5.00E-03	1.05E-02
Chrysene	2.10E-01	1.28E-05	2.69E-06	ND	NA
Copper	4.20E+00	1.28E-05	5.38E-05	ND	NA
DDD	3.70E-02	1.28E-05	4.74E-07	ND	NA
DDT	2.87E-01	1.28E-05	3.67E-06	5.00E-04	7.35E-03
Fluoranthene	3.60E-01	1.28E-05	4.61E-06	4.00E-02	1.15E-04
Lead	1.30E+01	1.28E-05	1.66E-04	ND	NA
Phenanthrene	2.10E-01	1.28E-05	2.69E-06	ND	NA
Pyrene	3.20E-01	1.28E-05	4.10E-06	3.00E-02	1.37E-04
Zinc	2.23E+01	1.28E-05	2.85E-04	2.00E-01	1.43E-03
				HAZARD INDEX =	2E-02

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 12.8
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	3.49E-07	8.73E-08	1.15E+01	1.00E-06
Chrysene	2.10E-01	3.49E-07	7.33E-08	1.15E+01	8.43E-07
DDD	3.70E-02	3.49E-07	1.29E-08	2.40E-01	3.10E-09
DDT	2.87E-01	3.49E-07	1.00E-07	3.40E-01	3.41E-08
Lead	1.30E+01	3.49E-07	4.54E-06	ND	NA
				CARCINOGENIC RISK =	2E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.

ND - Not Determined

NA - Not Applicable

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TABLE 12.9
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	9.78E-07	2.45E-07	ND	NA
Chromium (d)	4.10E+00	9.78E-07	4.01E-06	5.00E-03	8.02E-04
Chrysene	2.10E-01	9.78E-07	2.05E-07	ND	NA
Copper	4.20E+00	9.78E-07	4.11E-06	ND	NA
DDD	3.70E-02	9.78E-07	3.62E-08	ND	NA
DDT	2.87E-01	9.78E-07	2.81E-07	5.00E-04	5.61E-04
Fluoranthene	3.60E-01	9.78E-07	3.52E-07	4.00E-02	8.80E-06
Lead	1.30E+01	9.78E-07	1.27E-05	ND	NA
Phenanthrene	2.10E-01	9.78E-07	2.05E-07	ND	NA
Pyrene	3.20E-01	9.78E-07	3.13E-07	3.00E-02	1.04E-05
Zinc	2.23E+01	9.78E-07	2.18E-05	2.00E-01	1.09E-04
				HAZARD INDEX =	1E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 12.10
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	5.87E-07	1.47E-07	1.15E+01	1.69E-06
Chrysene	2.10E-01	5.87E-07	1.23E-07	1.15E+01	1.42E-06
DDD	3.70E-02	5.87E-07	2.17E-08	2.40E-01	5.21E-09
DDT	2.87E-01	5.87E-07	1.68E-07	3.40E-01	5.73E-08
Lead	1.30E+01	5.87E-07	7.63E-06	ND	NA
				CARCINOGENIC RISK =	3E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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AD-A277 094 INSTALLATION RESTORATION PROGRAM REMEDIAL INVESTIGATION 6/6
REPORT VOLK FIELD AIR NATIONAL GUARD CAMP DOUGLAS
WISCONSIN VOLUME 1(U) MARTIN MARIETTA ENERGY SYSTEMS
UNCLASSIFIED INC OAK RIDGE TN SEP 93 XD-NGB NL

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TABLE 12.11
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	1.37E-06	3.43E-07	ND	NA
Chromium (d)	4.10E+00	1.37E-06	5.62E-06	5.00E-03	1.12E-03
Chrysene	2.10E-01	1.37E-06	2.88E-07	ND	NA
Copper	4.20E+00	1.37E-06	5.75E-06	ND	NA
DDD	3.70E-02	1.37E-06	5.07E-08	ND	NA
DDT	2.87E-01	1.37E-06	3.93E-07	5.00E-04	7.86E-04
Fluoranthene	3.60E-01	1.37E-06	4.93E-07	4.00E-02	1.23E-05
Lead	1.30E+01	1.37E-06	1.78E-05	ND	NA
Phenanthrene	2.10E-01	1.37E-06	2.88E-07	ND	NA
Pyrene	3.20E-01	1.37E-06	4.38E-07	3.00E-02	1.46E-05
Zinc	2.23E+01	1.37E-06	3.06E-05	2.00E-01	1.53E-04
				HAZARD INDEX =	2E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
(d) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

TABLE 12.12
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	3.20E-07	8.00E-08	1.15E+01	9.20E-07
Chromium (VI)	4.10E+00	NA (d)	NA	ND	NA
Chrysene	2.10E-01	3.20E-07	6.72E-08	1.15E+01	7.73E-07
DDD	3.70E-02	1.60E-06	5.92E-08	2.40E-01	1.42E-08
DDT	2.87E-01	1.60E-06	4.59E-07	3.40E-01	1.56E-07
Lead	1.30E+01	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	2E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for rmal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 12.13
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	3.73E-06	9.33E-07	ND	NA
Chromium (f)	4.10E+00	NA (e)	NA	5.00E-03	NA
Chrysene	2.10E-01	3.73E-06	7.83E-07	ND	NA
Copper	4.20E+00	NA (e)	NA	ND	NA
DDD	3.70E-02	1.86E-05	6.88E-07	ND	NA
DDT	2.87E-01	1.86E-05	5.34E-06	5.00E-04	1.07E-02
Fluoranthene	3.60E-01	3.73E-06	1.34E-06	4.00E-02	3.36E-05
Lead	1.30E+01	NA (e)	NA	ND	NA
Phenanthrene	2.10E-01	3.73E-06	7.83E-07	ND	NA
Pyrene	3.20E-01	3.73E-06	1.19E-06	3.00E-02	3.98E-05
Zinc	2.23E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-02

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 12.14
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	4.74E-07	1.19E-07	1.15E+01	1.36E-06
Chromium (VI)	4.10E+00	NA (d)	NA	ND	NA
Chrysene	2.10E-01	4.74E-07	9.95E-08	1.15E+01	1.14E-06
DDD	3.70E-02	2.37E-06	8.77E-08	2.40E-01	2.10E-08
DDT	2.87E-01	2.37E-06	6.80E-07	3.40E-01	2.31E-07
Lead	1.30E+01	NA (d)	NA	ND	NA
			CARCINOGENIC RISK =		3E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 12.15
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM SURFACE SOILS BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	1.33E-06	3.33E-07	ND	NA
Chromium (f)	4.10E+00	NA (e)	NA	5.00E-03	NA
Chrysene	2.10E-01	1.33E-06	2.79E-07	ND	NA
Copper	4.20E+00	NA (e)	NA	ND	NA
DDD	3.70E-02	6.64E-06	2.46E-07	ND	NA
DDT	2.87E-01	6.64E-06	1.91E-06	5.00E-04	3.81E-03
Fluoranthene	3.60E-01	1.33E-06	4.79E-07	4.00E-02	1.20E-05
Lead	1.30E+01	NA (e)	NA	ND	NA
Phenanthrene	2.10E-01	1.33E-06	2.79E-07	ND	NA
Pyrene	3.20E-01	1.33E-06	4.26E-07	3.00E-02	1.42E-05
Zinc	2.23E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	4E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 12.16
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzo(b)fluoranthene	2.50E-01	1.89E-07	4.73E-08	1.15E+01	5.43E-07
Chromium (VI)	4.10E+00	NA (d)	NA	ND	NA
Chrysene	2.10E-01	1.89E-07	3.97E-08	1.15E+01	4.56E-07
DDD	3.70E-02	9.43E-07	3.49E-08	2.40E-01	8.37E-09
DDT	2.87E-01	9.43E-07	2.71E-07	3.40E-01	9.20E-08
Lead	1.30E+01	NA (d)	NA	ND	NA
				CARCINOGENIC RISK =	1E-06

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Dermal absorption for metals = 0.
ND – Not Determined
NA – Not Applicable

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TABLE 12.17
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM
SURFACE SOILS BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Soil (b) (mg/kg)	Intake Variable (c) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzo(b)fluoranthene	2.50E-01	4.40E-07	1.10E-07	ND	NA
Chromium (f)	4.10E+00	NA (e)	NA	5.00E-03	NA
Chrysene	2.10E-01	4.40E-07	9.24E-08	ND	NA
Copper	4.20E+00	NA (e)	NA	ND	NA
DDD	3.70E-02	2.20E-06	8.14E-08	ND	NA
DDT	2.87E-01	2.20E-06	6.31E-07	5.00E-04	1.26E-03
Fluoranthene	3.60E-01	4.40E-07	1.58E-07	4.00E-02	3.96E-06
Lead	1.30E+01	NA (e)	NA	ND	NA
Phenanthrene	2.10E-01	4.40E-07	9.24E-08	ND	NA
Pyrene	3.20E-01	4.40E-07	1.41E-07	3.00E-02	4.69E-06
Zinc	2.23E+01	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-03

(a) Based on compounds detected in top 2 feet of soil.
(b) Concentration in soil represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
(f) RfD used is for Chromium (VI).
ND - Not Determined
NA - Not Applicable

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TABLE 12.18
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF
GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.90E-03	1.10E-02	2.09E-05	2.90E-02	6.06E-07
Cadmium	1.02E-02	1.10E-02	1.12E-04	ND	NA
			CARCINOGENIC RISK =		6E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.19
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.90E-03	1.28E-01	2.43E-04	ND	NA
Cadmium	1.02E-02	1.28E-01	1.31E-03	5.00E-04	2.61E+00
Ethylbenzene	2.10E-03	1.28E-01	2.69E-04	1.00E-01	2.69E-03
Toluene	8.00E-04	1.28E-01	1.02E-04	2.00E-01	5.12E-04
Xylene	7.10E-03	1.28E-01	9.09E-04	2.00E+00	4.54E-04
Zinc	3.08E-02	1.28E-01	3.94E-03	2.00E-01	1.97E-02
				HAZARD INDEX =	3E+00

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.20
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF
GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.90E-03	3.49E-03	6.63E-06	2.90E-02	1.92E-07
Cadmium	1.02E-02	3.49E-03	3.56E-05	ND	NA
				CARCINOGENIC RISK =	2E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.21
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.90E-03	9.78E-03	1.86E-05	ND	NA
Cadmium	1.02E-02	9.78E-03	9.98E-05	5.00E-04	2.00E-01
Ethylbenzene	2.10E-03	9.78E-03	2.05E-05	1.00E-01	2.05E-04
Toluene	8.00E-04	9.78E-03	7.82E-06	2.00E-01	3.91E-05
Xylene	7.10E-03	9.78E-03	6.94E-05	2.00E+00	3.47E-05
Zinc	3.08E-02	9.78E-03	3.01E-04	2.00E-01	1.51E-03
				HAZARD INDEX =	2E-01

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

TABLE 12.22
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.90E-03	1.17E-02	2.22E-05	2.90E-02	6.45E-07
Cadmium	1.02E-02	1.17E-02	1.19E-04	ND	NA
			CARCINOGENIC RISK =		6E-07

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.23
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	1.90E-03	2.74E-02	5.21E-05	ND	NA
Cadmium	1.02E-02	2.74E-02	2.79E-04	5.00E-04	5.59E-01
Ethylbenzene	2.10E-03	2.74E-02	5.75E-05	1.00E-01	5.75E-04
Toluene	8.00E-04	2.74E-02	2.19E-05	2.00E-01	1.10E-04
Xylene	7.10E-03	2.74E-02	1.95E-04	2.00E+00	9.73E-05
Zinc	3.08E-02	2.74E-02	8.44E-04	2.00E-01	4.22E-03
				HAZARD INDEX =	6E-01

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are not adjusted for absorption.
ND – Not Determined
NA – Not Applicable

TABLE 12.24
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.90E-03	6.70E-06	1.27E-08	2.90E-02	3.69E-10
Cadmium	1.02E-02	6.70E-06	6.83E-08	ND	NA
			CARCINOGENIC RISK =		4E-10

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.25
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.90E-03	7.82E-05	1.49E-07	ND	NA
Cadmium	1.02E-02	NA (e)	NA	5.00E-04	NA
Ethylbenzene	2.10E-03	7.82E-05	1.64E-07	1.00E-01	1.64E-06
Toluene	8.00E-04	7.82E-05	6.26E-08	2.00E-01	3.13E-07
Xylene	7.10E-03	7.82E-05	5.55E-07	2.00E+00	2.78E-07
Zinc	3.08E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	2E-06

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 12.26
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope RfD (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	1.90E-03	1.91E-05	3.63E-08	2.90E-02	1.05E-09
Cadmium	1.02E-02	1.91E-05	1.95E-07	ND	NA
			CARCINOGENIC RISK =		1E-09

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 12.27
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	1.90E-03	4.46E-05	8.47E-08	ND	NA
Cadmium	1.02E-02	NA (e)	NA	5.00E-04	NA
Ethylbenzene	2.10E-03	4.46E-05	9.37E-08	1.00E-01	9.37E-07
Toluene	8.00E-04	4.46E-05	3.57E-08	2.00E-01	1.78E-07
Xylene	7.10E-03	4.46E-05	3.17E-07	2.00E+00	1.58E-07
Zinc	3.08E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-06

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND – Not Determined
NA – Not Applicable

TABLE 12.28
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	1.90E-03	5.43E-03	1.21E-01	8.3E-06	1.0E-06
				CARCINOGENIC RISK =	1E-06

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 12.29
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	1.90E-03	5.43E-03	1.41E-03	ND	NA
Ethylbenzene	2.10E-03	8.44E-03	2.42E-03	1.0E+00	2.42E-03
Toluene	8.00E-04	5.94E-03	6.49E-04	2.0E+00	3.24E-04
Xylene	7.10E-03	5.10E-03	4.94E-03	3.0E-01	1.65E-02
				HAZARD INDEX =	2E-02

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 12.30
SITE 9, FORMER LANDFILL B
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	1.90E-03	5.43E-03	6.04E-01	8.3E-06	5.0E-06
			CARCINOGENIC RISK =		5E-06

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 12.31
SITE 9, FORMER LANDFILL B
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	1.90E-03	5.43E-03	1.41E-03	ND	NA
Ethylbenzene	2.10E-03	8.44E-03	2.42E-03	1.0E+00	2.42E-03
Toluene	8.00E-04	5.94E-03	6.49E-04	2.0E+00	3.24E-04
Xylene	7.10E-03	5.10E-03	4.94E-03	3.0E-01	1.65E-02
				HAZARD INDEX =	2E-02

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the maximum detected concentration.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 12.32
SITE 9, FORMER LANDFILL B
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Pathway Risk	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	2E-06	Benzo(b)fluoranthene, Chrysene
	Dermal Absorption from Surface Soils	3E-06	Benzo(b)fluoranthene, Chrysene
Future Onsite Workers	Incidental Ingestion of Surface Soils	2E-06	Benzo(b)fluoranthene, Chrysene
	Dermal Absorption from Surface Soils	3E-06	Benzo(b)fluoranthene, Chrysene
	Ingestion of Groundwater	2E-07	Benzene
Future Adult Residents	Ingestion of Groundwater	6E-07	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	5E-06	Benzene
	Dermal Absorption from Groundwater	1E-09	Benzene
	Incidental Ingestion of Surface Soils	3E-06	Benzo(b)fluoranthene, Chrysene
	Dermal Absorption from Surface Soils	1E-06	Benzo(b)fluoranthene, Chrysene
Future Children	Ingestion of Groundwater	6E-07	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	1E-06	Benzene
	Dermal Absorption from Groundwater	4E-10	Benzene
	Incidental Ingestion of Surface Soils	6E-06	Benzo(b)fluoranthene, Chrysene
	Dermal Absorption from Surface Soils	2E-06	Benzo(b)fluoranthene, Chrysene

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TABLE 12.33
SITE 9, FORMER LANDFILL B
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Onsite Workers	Incidental Ingestion of Surface Soils	1E-03	Chromium, DDT
	Dermal Absorption from Surface Soils	4E-03	DDT
Future Onsite Workers	Incidental Ingestion of Surface Soils	1E-03	Chromium, DDT
	Dermal Absorption from Surface Soils	4E-03	DDT
	Ingestion of Groundwater	2E-01	Cadmium
Future Adult Residents	Ingestion of Groundwater	6E-01	Cadmium
	Inhalation of VOCs Released from Groundwater during Showering	2E-02	Xylene
	Dermal Absorption from Groundwater	1E-06	Ethylbenzene
	Incidental Ingestion of Surface Soils	2E-03	Chromium, DDT
	Dermal Absorption from Surface Soils	1E-03	DDT
Future Children	Ingestion of Groundwater	3E+00	Cadmium
	Inhalation of VOCs Released from Groundwater during Showering	2E-02	Xylene
	Dermal Absorption from Groundwater	2E-06	Ethylbenzene
	Incidental Ingestion of Surface Soils	2E-02	Chromium, DDT
	Dermal Absorption from Surface Soils	1E-02	DDT

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TABLE 12.34
CHEMICAL CONSTITUENTS DETECTED AT SITE 9 AND CORRESPONDING ARARs
VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Benzo(b)fluoranthene	1990	0.25	--	--	--
Chromium (VI)	1990	4.1	--	--	--
Chrysene	1990	0.21	--	--	--
Copper	1990	4.2	--	--	--
4,4-DDD	1990	0.037	--	--	--
4,4-DDT	1990	0.287	--	--	--
Fluoranthene	1990	0.36	--	--	--
Lead	1990	13	--	--	--
Mercury	1990	0.021	--	--	--
Nickel	1990	2.6	--	--	--
Phenanthrene	1990	0.21	--	--	--
Pyrene	1990	0.32	--	--	--
Zinc	1990	22.3	--	--	--
Groundwater (ug/L)					
Benzene	1988	1.9	MCL/WIDNR	5	No
Cadmium	1990	10.2	MCL	5	Yes
Chromium (VI)	1988	10(1)	WIDNR	50	No
Copper	1988	20(1)	WIDNR	1,000	No
Ethylbenzene	1988	2.1	MCL	700	No
Lead	1988	6(1)	MCL	15	No
Silver	1988	180(1)	WIDNR	50	Yes
TDS	1988, 1990	178,000	--	--	--
Thallium	1988	100(2)	--	--	--
Toluene	1988	0.8	WIDNR	343	No
Xylenes	1988	7.1	WIDNR	620	No
Zinc	1988, 1990	30.8	MCL/WIDNR	5,000	No

MCL - Safe Drinking Water Act Maximum Contaminant Level.
WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.
(1) - Unfiltered sample; detected concentration not used in risk assessment.
(2) - Detected in background sample or upgradient well.

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SECTION 13
SITE 10 - MUNITIONS BURIAL SITE

BACKGROUND

A description and history of Site 10 is provided in this subsection. The activities included during the three field investigations under the IRP are also summarized.

Site Description

Site 10 is located on the west side of Hardwood Range, approximately 1,600 feet south-southwest of the central control tower and approximately 2,000 feet east of the westernmost Range property line. Since 1976, the site has been used for the burning and burial of spent munitions. The munitions have been burned and covered in an area which is approximately 200 feet by 90 feet as shown on Figure 13.1. This landfill is approximately 10 feet higher than the surrounding grade. Approximately 20 feet west of the landfill is a smaller area where munitions were stored prior to their burial. Standing water is present approximately 120 feet southeast of the landfill.

Site History

Munitions buried at this site include spent BDU-33 practice bombs, 2.75 rocket heads, MK-106 projectiles and 20 mm and 30 mm shells. Spent munitions have been burned on an average of once each year since 1976. Since the early 1980s approximately 500 gallons of JP-4 have been employed as fuel for burning the munitions. Prior to that time waste fuels, solvents and thinners were used as the fuel source. In the spring of 1988, the munitions stored in the trench located to the west of the landfill were burned and buried within the landfill area, and the area was subsequently regraded.

1987 Activities

The 1987 SI at Site 10 included the installation and sampling of four monitoring wells. Aromatic volatile and semivolatile organic contaminants were detected in the sample and duplicate sample collected from MW-4. No chemical constituents were found in samples from the other three monitoring wells. This data is presented in Appendix G.

1989 Activities

Field work performed in 1989 included monitoring well installation, groundwater and surface water sampling, water level measurements and surveying. Three monitoring wells (MW-5, MW-6 and MW-7) were installed in 1989. The location of these monitoring wells in indicated on Figure 13.2. Monitoring wells MW-6 and MW-7 were screened from 6 to 16 feet and installed downgradient of Site 10 to define the horizontal extent of contamination. Well MW-5 was positioned to form a cluster pair with MW-4. MW-5 was screened from 50 to 60 feet to determine if contamination is moving downward. All seven monitoring wells were sampled and analyzed for halogenated and aromatic volatile organics, TPH, TDS, metals and semivolatile organics. Groundwater elevations were measured on December 12, 1989.

Samples were collected from the three surface water stations shown on Figure 13.1. The samples were analyzed for the same parameters as the groundwater samples. After sampling was completed, the surface water stations and the three newly installed wells were surveyed.

1990 Activities

Field activities performed in 1990 included soil boring, soil and groundwater sampling, groundwater elevation measurements, land surveying and a groundwater use survey.

Three shallow soil borings were advanced to a maximum depth of 1 foot to obtain soil samples. Two borings (SB-1 and SB-2) were located in the buried munition landfill; SB-3, the background boring, was positioned north of the landfill. A surface soil sample was obtained from each boring and analyzed for halogenated and aromatic volatile organics, semivolatile organics, metals, pesticides and PCBs.

Water level measurements and groundwater samples were taken at each of the seven wells. The samples were analyzed for the same parameters as in 1989. After sampling was completed, the three soil borings were surveyed and the cluster well pair (MW-4 and MW-5) was resurveyed.

ES personnel conducted a groundwater use survey to identify any potential receptors (residents or business) located downgradient of Hardwood Range .

1991 Field Activities

The 1991 field activities consisted of water level measurements. Water elevations were obtained from all monitoring wells on 30 October 1991.

RESULTS

The results of the investigations are provided in this subsection.

Geology/Hydrogeology

Test borings indicate Site 10 is underlain by yellowish-brown, mostly fine sand with occasional clay lenses. The unconsolidated sediments persisted to a depth of 64 feet, which was the maximum depth drilled. The lithology, like those encountered at the Base, consists of Pleistocene lake deposits, with an estimated thickness of 75 to 150 feet. Soil boring and well construction logs are presented in Appendix B. A hydrogeologic cross-section was constructed for Site 10. The cross-section location is shown on Figure 13.3 and the cross-section is presented on Figure 13.4.

Groundwater elevations measured on 14 November 1990 indicate flow toward the south-southeast with an average hydraulic gradient of 0.0011 ft/ft (Figure 13.2). A vertical, downward gradient of 0.0578 ft/ft exists between MW-4 and MW-5. These gradients are consistent with gradients calculated in 1989. A groundwater contour map for October 1991 indicated a flow direction to the southwest (see Appendix B - Groundwater Level Summary). These measurements were obtained during a period of significant rainfall. Such a change could be attributed to a recharge area east of the site. A low lying area and drainage features are present southeast of the site and may influence groundwater flow patterns during rainfall events. Groundwater elevation data are presented in Table 2.4 of the Environmental Setting (Section 2); a complete summary of groundwater measurements is found in Appendix B.

The groundwater use survey performed by ES personnel identified potential wells locations which were downgradient of the Hardwood Range boundary. These wells are mostly residential wells used for drinking water. The nearest drinking water well downgradient of the site is at a distance of approximately 1 mile. Two water supply wells are located on Hardwood Range, upgradient of Site 10. These wells are located on Figure 13.5.

The estimated groundwater flow velocity for this area is 0.07 ft/day or 25.6 ft/yr. This is based upon a hydraulic conductivity of 95.4 gpd/ft^2 (estimated from 1988 slug tests) [ES, 1990c], the hydraulic gradient and an effective porosity of 0.2 [Bouwer, 1978].

Soil Sampling Results

Organic compounds were not detected in the three surface soil samples collected at Site 10; however, several inorganics were found. Table 13.1 summarizes the 1990 soils data. Chromium (2.6 mg/kg), copper (2.3 mg/kg), nickel (1.5 mg/kg) and zinc (3.7 mg/kg) were detected in the background sample from boring SB-3. The sample from SB-1 contained mercury at 0.011 mg/kg and lead was found in the sample from SB-2 at 1.1 mg/kg. None of the metals exceed guidance criteria for metals concentrations in soils.

Groundwater Sampling Results

In 1987, wells MW-1, MW-2, MW-3 and MW-4 were installed and sampled to confirm or deny the presence of contamination. BETX were detected in the sample from well MW-4. Benzene, ethylbenzene, toluene and xylenes were detected at maximum concentrations of 167, 16.6, 149 and 58.7 μg/L, respectively. Naphthalene was detected at 2 μg/L and lead was detected at a concentration of 6 μg/L. These results obtained during the 1987 SI [ES, 1990c] have been included in the risk assessment and are summarized in Appendix G.

In 1989, three additional wells were installed and sampled during the RI to determine the extent of contamination. Well MW-5 was installed to determine if the contaminants were moving downward; wells MW-6 and MW-7 were installed to further investigate the horizontal extent of contamination. The contaminants detected in 1987 in well MW-4 were not detected in the samples from the three new wells. Chloroform was detected at 15 μg/L in the sample from MW-7. Chloroform was also detected in the HPLC field blank at 0.55 μg/L, but this concentration is retained in the risk assessment because it exceeded the concentration in the blank by more than 10 times. The factor of 10 times was used because chloroform is considered a common laboratory contaminant. Bis(2-ethylhexyl)phthalate was detected in the duplicate sample collected at MW-5 at an estimated concentration of 12 μg/L; however, it was not detected in the sample from MW-5 nor was it found in MW-5 in 1990. Dissolved zinc was detected below any criteria in samples from all three wells. The analytical results are summarized in Table 13.2.

In 1990, all seven of the wells were resampled to confirm the previous results. Benzene, toluene and xylenes were once again detected in the sample collected at MW-4. Benzene was found at 30 μg/L. This concentration is considerably lower than the concentration detected in 1987 but remains in excess of the MCL of 5 μg/L. Neither the toluene nor xylenes concentrations exceed identified criteria. In addition, benzene was detected for the first time in a sample from MW-3 at 42 μg/L which exceeds ARARs. The presence of benzene in this well in 1990 and not in the earlier sampling events may be the effect of temporary changes in the groundwater flow pattern at this site. As discussed in the hydrogeology section, such a change has been observed at this site. Dissolved zinc was detected at concentrations comparable to those detected in 1989. Groundwater analytical results for 1990 are summarized in Table 13.3. Volatile organics detected in groundwater during 1989 and 1990 are identified on Figure 13.6. This figure also depicts the estimated extent of groundwater containing volatile organics. The results for inorganic analyses from the 1988 groundwater sampling are not directly comparable to the 1989 and 1990 groundwater sampling events because the earlier samples were obtained from unfiltered samples.

Surface Water Sampling Results

The only analytes detected in the three surface water samples were TPH at 2.8 mg/L, bis(2-ethylhexyl)phthalate estimated at 35 μg/L and TDS in all three samples at 78, 78 and 100 mg/L (Table 13.4). No organics or metals were detected in surface water samples.

BASELINE RISK ASSESSMENT

The following subsections present the Site 10 baseline risk assessment. The human health evaluation is presented first and is followed by the ecological evaluation and the conclusions of the risk assessment. Analytical results for groundwater samples from the 1988 SI [ES, 1990c] were used along with the 1989 and 1990 analytical results in the preparation of this risk assessment. An exception is that the 1988 metals data was not used as this data was for unfiltered samples.

The risk assessment presented here was conducted according to the most recent EPA guidelines and considers all of the available site monitoring data through 1991. These risk assessment procedures are outlined in Section 4. The available toxicity information for the chemicals detected at this site is presented in Section 4 and Appendix F.

Selection of Chemicals of Concern

Metals, VOCs and semivolatile organic compounds were detected in soils, surface water, and groundwater associated with Site 10. Based on the chemicals detected in 1988, 1989 and 1990 rounds of sampling and the baseline risk assessment procedures described in Section 4, chemicals of concern were selected for each medium.

Surface Soils

Six metals (chromium, copper, nickel, zinc, mercury, and lead) were the only chemicals detected in surface soil samples collected from Site 10. The detected concentrations of these metals did not exceed three times the respective minimum background concentrations (Table 4.5). Therefore, no chemicals of concern were selected for surface soils.

Groundwater

Chemicals detected in the groundwater at Site 10 have included: benzene, bis (2-ethylhexyl)phthalate, chloroform, ethylbenzene, naphthalene, TDS, TPH, toluene, xylene and zinc. All of these analytes except total dissolved solids (TDS) were selected as chemicals of concern for groundwater at Site 10. These chemicals along with the arithmetic average, standard deviation, and 95 percent UCL for the arithmetic average are presented in Table 13.5. The 95 percent UCL for the arithmetic average of each chemical detected in the groundwater at Site 10 was then used in estimating exposure.

Surface Water

Bis(2-ethylhexyl)phthalate, TDS and TPH were the only analytes detected in the two surface water samples collected downstream of the site. Both bis(2-ethylhexyl)phthalate and TPH were selected as chemicals of concern. Since only three surface water samples were collected for laboratory analysis, the maximum detected concentration was used (instead of the 95 percent UCL of the arithmetic average) to estimate exposures. Table 13.6 presents the two chemicals of concern detected in surface water and the arithmetic averages, standard deviations and maximum detected concentrations of these analytes.

Human Health Evaluation

The human health evaluation is presented in the following subsection.

Exposure Pathways

Potential sources for contaminant release at this site include the fuels, solvents, thinners, and munitions disposed at the site and the surface water or groundwater in which chemicals of concern have been detected. Exposure points are locations where human receptors could come into contact with waste materials, contaminated media, or releases from either. Potential exposure points considered for Site 10 are the nearby surface waters and groundwater at and downgradient of the site.

Receptors are individuals who are (currently) or could be exposed (in the future) to the chemicals of concern via an exposure route (e.g. ingestion, absorption, etc.) at an exposure point. The site is no longer used for disposal of munitions and the site is located 2,000 feet inside the Base and access by personnel not living or working on the Base is therefore limited. However, access to Site 10 is not controlled by fencing.

Based upon the remote location of this site, children who currently live off-Base are unlikely to wander onto the Base and should not therefore be exposed at Site 10; however, onsite Base workers could be exposed during work activities at the site. Hypothetical (future) exposure pathways would include exposures to: onsite workers who might (in the future) work on the site and adults and children who might (in the future) take up residence on the site.

The source area at Site 10 is marked by warning signs and a wire line which surrounds the perimeter. The source area is covered by sparse vegetation. People who have occasion to be in close proximity to Site 10 are primarily Base personnel who maintain the roadway adjacent to the site. Hardwood Range is open to the public during hunting season, which may result in a limited number of people passing by this site. Hardwood Range allows visitors during practice bombings; however, access is limited to the control tower located north of Site 10.

Exposure pathways for each of the environmental media (i.e., soils, groundwater, surface water, and air) are discussed below. The potential human exposure pathways which were evaluated for Site 10 are summarized in Table 13.7

Soils. No contaminants were detected in site soils, therefore exposures to site soils now or in the future do not present a risk for human receptors.

Groundwater. Private water supply wells exist downgradient (northeast) of Site 10. The nearest of these wells is approximately 1 mile away. Since chemicals were detected in monitoring wells immediately downgradient of the site, contamination of the downgradient drinking water supply wells is possible. Exposure could occur via ingestion of groundwater, dermal contact with groundwater during showering, and inhalation of volatile organic compounds released from groundwater during showering. The oral pathways would apply to hypothetical (future) onsite workers as well as residents. The dermal and inhalation pathways would apply mainly to hypothetical (future) residents who might shower or bathe with the contaminated groundwater.

There are two water supply wells which are located at Hardwood Range, but these wells are upgradient of the munitions burial area.

Surface Water. Site 10 lies within the drainage of the Yellow River which joins the Wisconsin River 25 miles south of Hardwood Range. Hardwood Range is dissected by natural and man-made water channels. Site 10 is in a swampy area of Hardwood Range. Two surface channels near Site 10 carry surface runoff from the site, and standing water is present southeast of the site. Total petroleum hydrocarbons and bis(2-ethylhexyl)phthalate were detected in one of three surface water samples taken downstream of Site 10. Exposure to these chemicals could occur during recreational use of the site (e.g., during hunting). To assess this potential exposure pathway, incidental ingestion of the surface water (such as during swimming) was assessed. This conservative approach was chosen simply to determine if a health risk might exist and was intended to reflect any actual/potential exposures.

Air. Chemicals were not detected in the soil samples collected from Site 10, and exposures to airborne contaminants were not, therefore, included in the human health evaluation.

In this assessment, exposure concentrations, exposure intakes (oral and dermal pathways only), and subsequent risks and hazard indices were calculated for the following hypothetical pathways:

Exposure Pathway	Group Affected	Carcinogenic Table No.	Noncarcinogenic Table No.
Ingestion of groundwater	Children	13.8	13.9
	Workers	13.10	13.11
	Adult residents	13.12	13.13
Dermal absorption from groundwater during showering(1)	Children	13.14	13.15
	Adult residents	13.16	13.17
Ingestion of surface water(2)	Children	13.18	13.19
	Adult residents	13.20	13.21
Inhalation of VOCs released from groundwater during showering(1)	Children	13.22	13.23
	Adult residents	13.24	13.25

(1) Workers were not considered to be exposed to contaminants in groundwater via showering (dermal and inhalation) because showering is assumed to take place at their homes.

(2) Scenario for exposure by this pathway involves routine incidental ingestion of small quantities of surface water. This scenario is more applicable to exposure during swimming but was used as a conservative estimate of health risks at this site for surface water pathways.

Risk Characterization

Carcinogenic Risks

A summary of the carcinogenic risks for each receptor is provided in Table 13.26. The calculated risks for each environmental medium and exposure pathway are discussed below.

Groundwater. Carcinogenic risks were evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from the groundwater during showering. All of the exposure pathways for onsite workers and hypothetical (future) residents had carcinogenic risks that were within EPAs acceptable risk range except for inhalation by future adult residents of VOCs released from groundwater during showering. The carcinogenic risk for this inhalation exposure pathway and hypothetical (future) receptor was two excess lifetime cancer cases per 10,000 persons exposed (2E-04). Benzene was the contaminant responsible for this elevated risk. However, this risk should be viewed in light of the relatively conservative set of assumptions used in this assessment (i.e., residential use of the site) and the marginal exceedance of EPA's acceptable risk range (site: 2E-04 versus EPA's target range: 1E-04 to 1E-06).

Surface Water. The carcinogenic risks for exposure of site residents to surface water were equal to or less than the lower end of EPA's acceptable carcinogenic risk range (adults: 1E-07 and children: 1E-06). Thus, even with a very conservative exposure scenario (involving ingestion of surface during swimming), the calculated risk for surface water exposure does not indicate unacceptable health risks are currently present or will occur in the future.

Noncarcinogenic Hazards

The potential for noncarcinogenic health effects was also assessed for the exposure pathways associated with this site. The calculated hazard indices for these noncarcinogenic exposures are provided in Table 13.27. A hazard index which exceeds 1 is an indication that adverse health effects are likely. The hazard index for each environmental medium and exposure pathway are discussed below.

Groundwater. Noncarcinogenic health hazards were also evaluated for three exposure pathways associated with groundwater contamination at this site. These exposure pathways involve ingestion of groundwater, dermal absorption of the chemicals detected in the groundwater (i.e., during showering) and inhalation of the volatile compounds released from groundwater during showering. All of the hazard indices were less than 1 for all groundwater exposure pathways. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., residential use of the site), the calculated hazard indices for groundwater exposure pathways at Site 10 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Surface Water. The hazard indices for the surface water exposure pathway and receptors were less than 1. Thus, even though a relatively conservative set of assumptions was used in this assessment (i.e., incidental ingestion such as during swimming), the calculated hazard indices for surface water exposure pathways at Site 10 do not indicate that noncarcinogenic health effects currently exist or are possible in the future.

Ecological Evaluation

Site 10, the munitions burial site at Hardwood Range, is situated in the Juneau County Forest. The forest is harvested for paper, is used for recreation, and is maintained as wildlife habitat. Vegetation in the forest consists mainly of scrub oak, aspen, jack pines and scrub willows. Farmland exists in the vicinity of Hardwood Range [U.S. Air Force, 1989]. This farmland is used primarily as cranberry bogs, corn and potato fields, and livestock ranges.

Many species of wildlife are found in the vicinity of Hardwood Range. Species of birds in the area include osprey, greater sandhill crane, great blue heron, bald eagles, ducks, geese, hawks, coots, pheasants, wild turkeys, grouse, owls, sandpipers, woodpeckers, wrens, crows, sparrows, warblers, and blackbirds. Mammals include deer, rabbit, squirrel, raccoon, mink, fox, otter, beaver, coyote, skunk, muskrat,

opossum, and bears. Several species which are listed as endangered by the State of Wisconsin have been sited in the vicinity of Hardwood Range. Endangered birds include peregrine falcon, bald eagle, osprey, loggerhead shrike, Forster's tern, and common tern. Furthermore, two species of endangered butterfly (dusted skipper and Karner blue butterfly), a turtle (Blandings) and a rattlesnake (Massasagua) have been identified within 9 miles of Hardwood Range. Breeding and wintering habitats for bald eagles are of particular concern in both Juneau and Wood Counties (U.S. Air Force, 1989; U.S. Dept. of Interior, 1988). Further information on site characterization is summarized in Section 4.

Exposure Assessment

Primary exposure pathways for ecological receptors at Site 10 could include:

- ingestion and dermal contact with contaminants present in surface runoff from the site by animals;
- uptake of contaminants in surface runoff by plants;
- uptake of contaminants in groundwater by plants; and
- ingestion of contaminated plants or animals.

Inhalation of contaminants released via fugitive dust generation is unlikely since the site is vegetated. No VOCs were detected in soils, thus no inhalation exposures resulting from VOC release from soils are expected.

Toxicity Assessment

There are no criteria to quantitatively evaluate the impacts of exposure of flora and fauna to chemicals in groundwater. However, toxicity values are available to evaluate compounds detected in the surface water associated with Site 10 and are presented in Table 4.10. These include water quality criteria for the protection of freshwater aquatic life and acute oral LD50s for mammals. There are no criteria for plants or birds. It should be noted these values can be used only in a qualitative way to screen for potential impacts. Acute LD50 values can only be used to highlight the detected chemicals that might be toxic to mammals.

Risk Characterization

None of the chemicals of concern detected in surface water had concentrations in excess of either acute or chronic water quality criteria for the protection of freshwater aquatic life. Also, there are no criteria to determine whether or not the concentrations of chemicals of concern in surface water might be detrimental to plants or mammals. However, an analysis of the acute oral LD50 values for mammals indicates that bis(2-ethylhexyl)phthalate is very slightly toxic to mammals. There is no LD50 by which to evaluate the potential impacts of TPH in surface drainage to mammals.

Risk Assessment Conclusions

In this subsection the conclusions and uncertainties of the baseline risk assessment are presented.

Human Receptors

Volatile, semivolatile, and inorganic contaminants were detected in groundwater at Site 10. Since onsite Base workers do not drink groundwater from wells downgradient of Site 10, there are no current risks for these receptors. There are houses with private wells downgradient of the site, but these wells are not known to be contaminated. Hypothetical (future) risks associated with the use of contaminated groundwater were calculated on the basis of groundwater samples taken from monitoring wells immediately downgradient of Site 10.

None of the risks calculated for exposures associated with ingestion or dermal contact with groundwater by either hypothetical residents or onsite workers were unacceptable. However, carcinogenic risks associated with inhalation of VOCs released from groundwater during showering for hypothetical adult residents was found to exceed EPA's target risk range. Hazard indices were less than one for all exposure pathways and potential receptors.

A general discussion of the uncertainties associated with the baseline risk assessment are given in Section 4. An important assumption made in this risk assessment is that contaminant concentrations will remain constant and not decrease over a long period of time, up to 30 years. However, organic compounds, especially benzene, detected in groundwater do degrade with time. This would result in an overall decrease in contaminant concentrations.

It should be noted that noncarcinogenic risks associated with the presence of TPH and benzene in groundwater could not be quantified due to the lack of reference toxicity information. TPH was also detected in one surface water sample but the existence of complete surface water exposure pathways is uncertain. Surface runoff from the site may drain through a cranberry farm located adjacent to the site. However, the potential impact of TPH on the cranberries and those who consume them is currently unknown and cannot be discerned without fundamental information on the toxicity of TPH as a class.

Another uncertainty concerns the presence of bis(2-ethylhexyl)phthalate in one surface water sample. Since this compound was not detected in either surface soils or groundwater, it seems unlikely that it should be present in runoff from the site. If bis(2-ethylhexyl)phthalate is actually released from the site, it should also be present in sediments due to a strong tendency to partition to soil and sediments [Howard, 1989]. Sediment samples would have to be collected to determine whether or not bis(2-ethylhexyl)phthalate is present in this media.

Ecological Receptors

Site 10 is located in the Juneau County Forest. Wetland areas, farmland and wildlife refuges are located in the area. Many species of wildlife, including endangered species such as the bald eagle and peregrine falcon have been located within a 9-mile radius of Hardwood Range.

Flora and fauna could be impacted by uptake of chemicals in surface water and groundwater at the site. Due to the lack of approved reference toxicity information, it is difficult to assess the potential impacts of the contaminants detected at Site 10 on ecological receptors. However, toxicity values are available to qualitatively evaluate compounds detected in surface water. Petroleum hydrocarbons and bis(2-ethylhexyl)phthalate were detected in surface water drainage. Given the fact that none of these contaminants bioconcentrate, impacts, if any, would be expected to be very low.

The potential impacts of chronic exposures to bis(2-ethylhexyl)phthalate, TPH, cannot be evaluated due to the lack of chronic water quality criteria. Based on acute oral toxicity values for mammals, bis(2-ethylhexyl)phthalate could be classified as very slightly toxic. There is no acute oral toxicity value for TPH. There are no toxicity values with which to evaluate potential impacts of contaminants in water to non-mammalian species.

CONCLUSIONS AND RECOMMENDATIONS

Benzene, ethylbenzene, toluene, xylenes, chloroform, naphthalene, bis(2-ethylhexyl)phthalate, TPH, lead and zinc have all been detected in the groundwater since 1987. One surface drainage sample contained TPH and another contained bis(2-ethylhexyl)phthalate.

The compounds detected in soils, groundwater and surface water at Site 10, including those detected during the 1988 sampling effort [ES, 1990c], are presented in Table 13.28. This table also provides a comparison of the maximum detected concentrations to ARARs introduced in Tables 4.1 through 4.4. ARARs exceeded at this site include the Wisconsin Enforcement Standard, the Federal MCL, and federal surface water criteria. ARAR for soils were not identified; however, To-Be-Considered criteria for soils are presented in Section 4. Compounds detected in groundwater which exceeded ARARs include benzene and chloroform. Bis(2-ethylhexyl)phthalate in surface water exceeded corresponding federal criteria.

The pathways for exposure considered at Site 10 included ingestion of groundwater, dermal absorption and inhalation of volatile organics released from groundwater, and ingestion of surface water. The only unacceptable health risk for this site was for inhalation of benzene from groundwater for hypothetical (future) adult residents during showering. This risk should be viewed in light of the relatively conservative set of assumptions used in the risk assessment (i.e., residential use of the site) and the marginal exceedance of EPA's acceptable risk

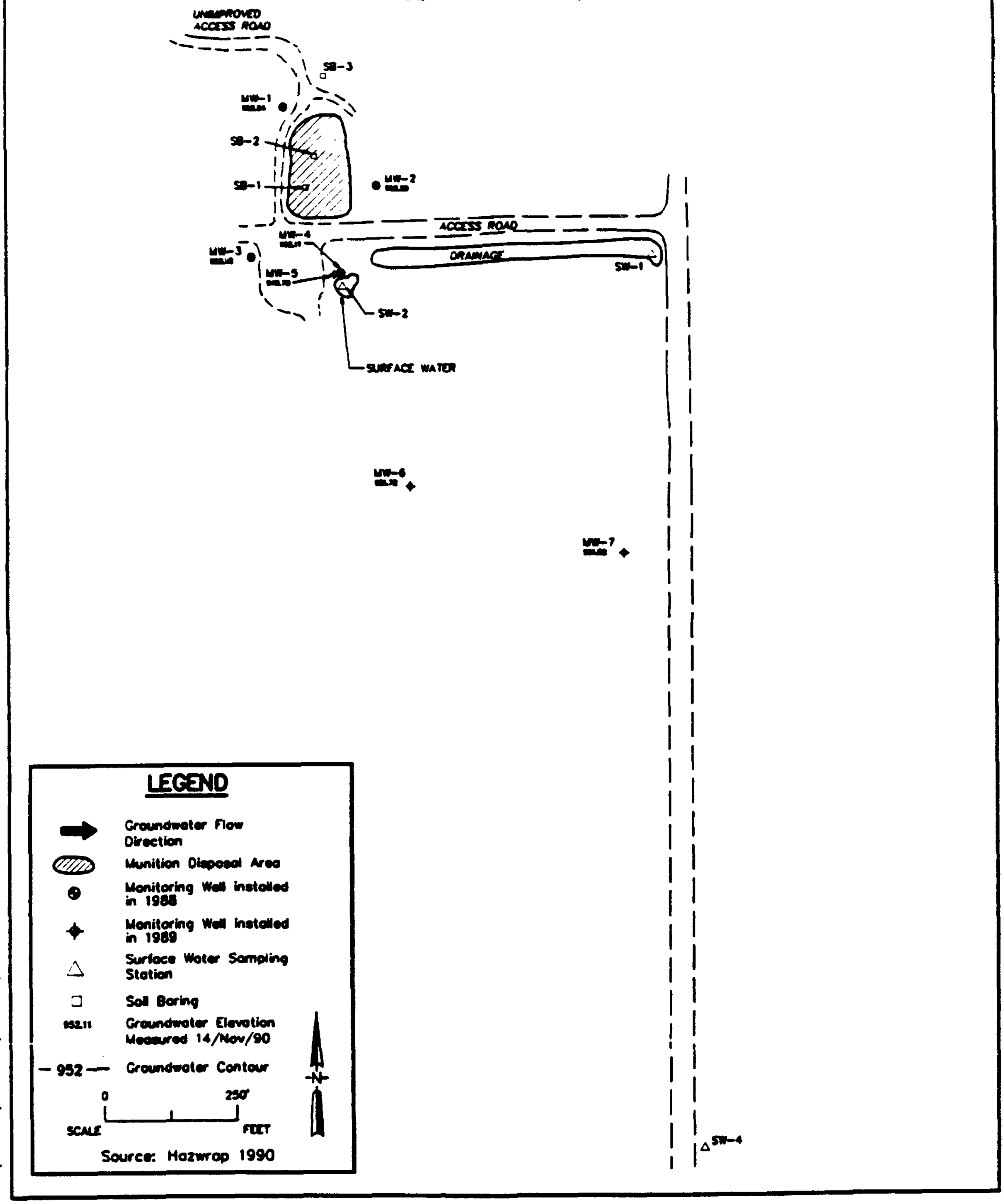
range (site: 2E-04 versus EPA's target range: 1E-04 to 1E-06). Also, the groundwater exposure pathways at this site are for hypothetical (future) residents and are not currently complete. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

The risk assessment at this site indicated that unacceptable risks are present. Also, ARARs for groundwater and surface water have been exceeded. ES recommends an FS be conducted to determine the best alternative for mitigation of the contaminants identified at the site. Source control and long-term monitoring may be appropriate.

Figure 13.1

SITE 10, MUNITIONS BURIAL SITE

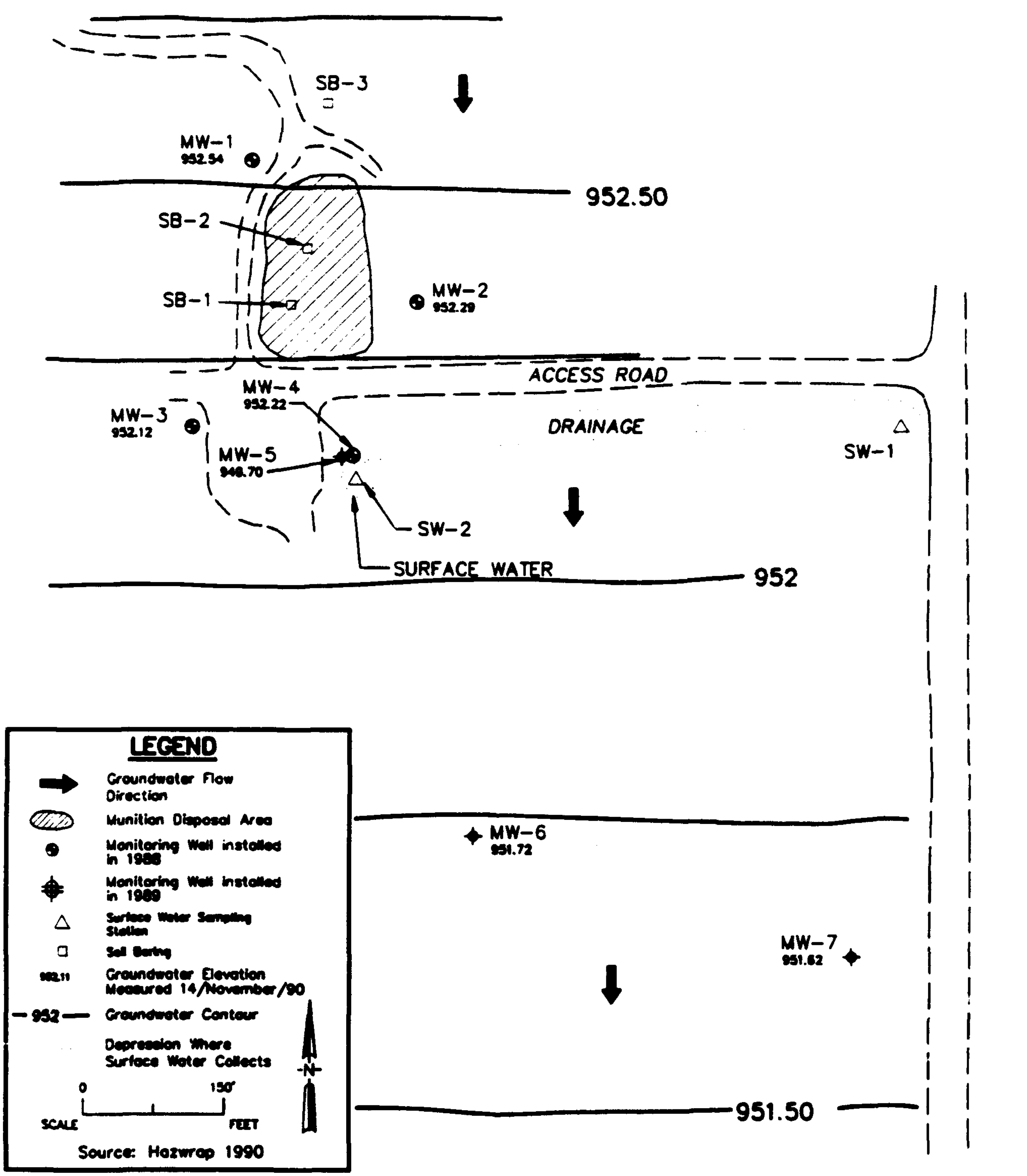
VOLK FIELD ANGB, WI



J:\JOBS\AT077\CADD\SITE-10, 12/12/91 at 17:06

Figure 13.2

SITE 10, MUNITIONS BURIAL SITE
GROUNDWATER CONTOUR MAP, 14 NOVEMBER 1990
VOLK FIELD ANGB, WI

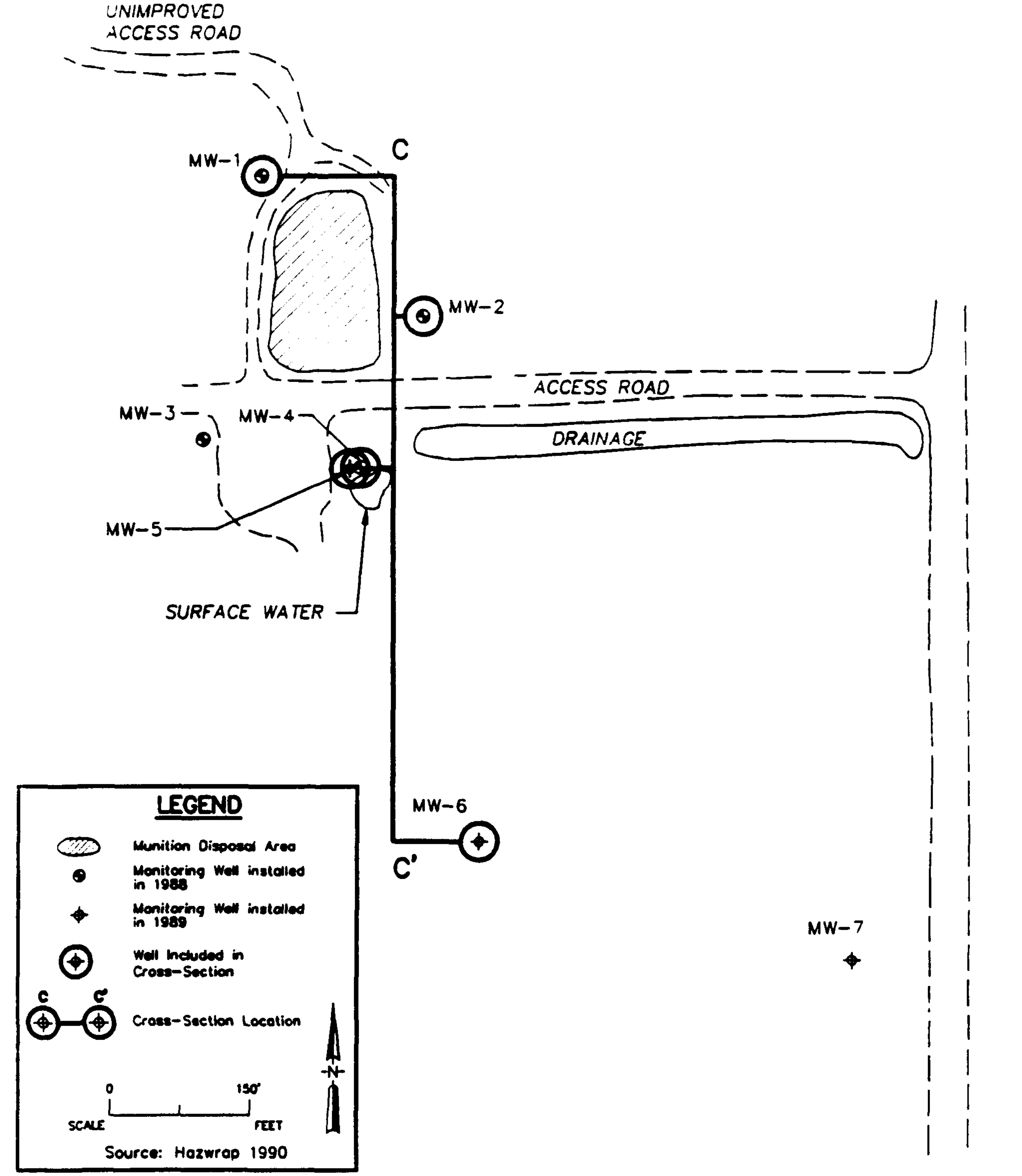


f:\jobs\at077\cadd\site-10b, 02/14/92 at 16:42

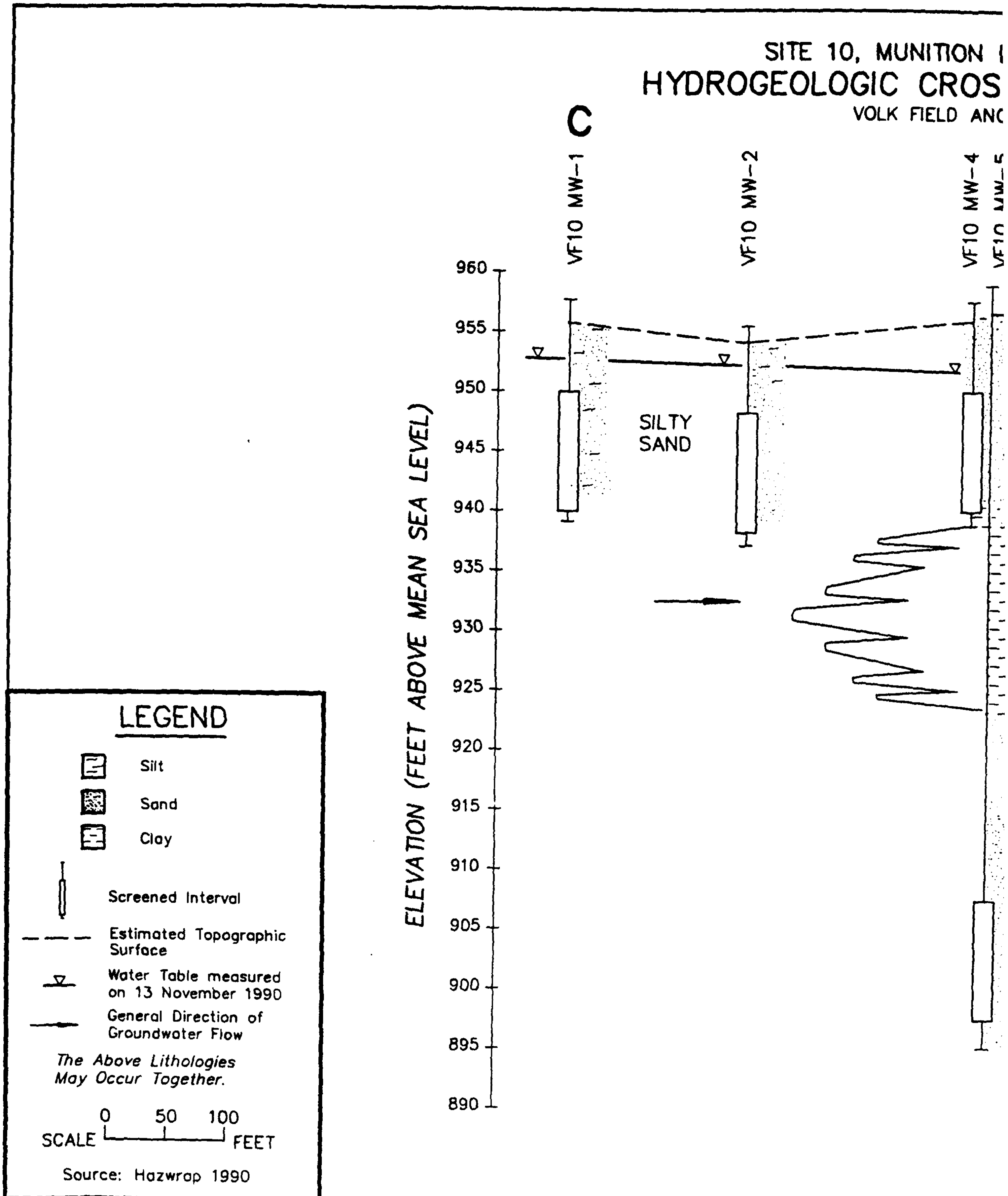
ENGINEERING-SCIENCE

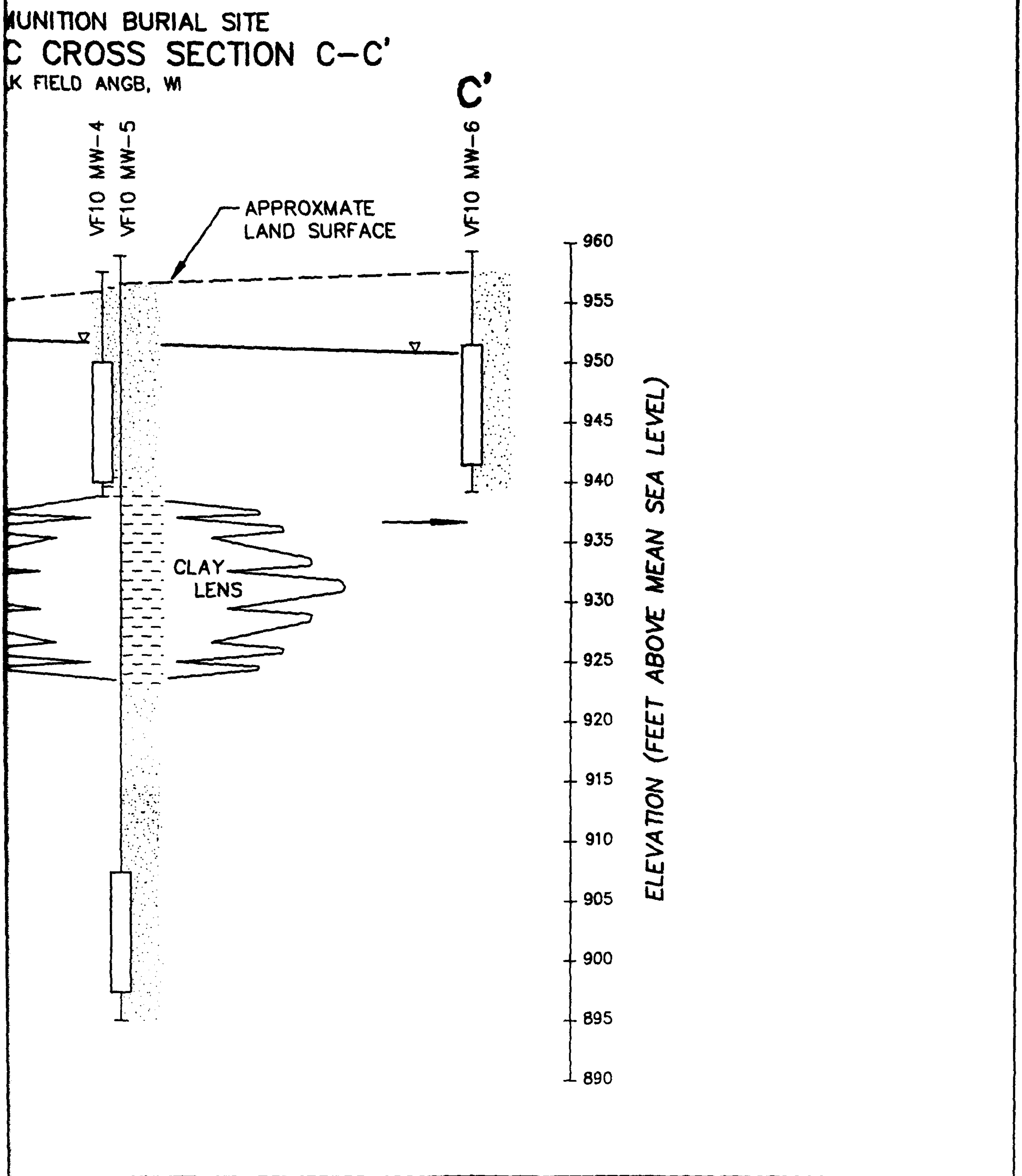
Figure 13.3

SITE 10, MUNITIONS BURIAL SITE
HYDROGEOLOGIC CROSS-SECTION LOCATION
VOLK FIELD ANGB, WI



J:\JOBS\AT077\CADD\CROSS10, 12/12/91 at 16:55

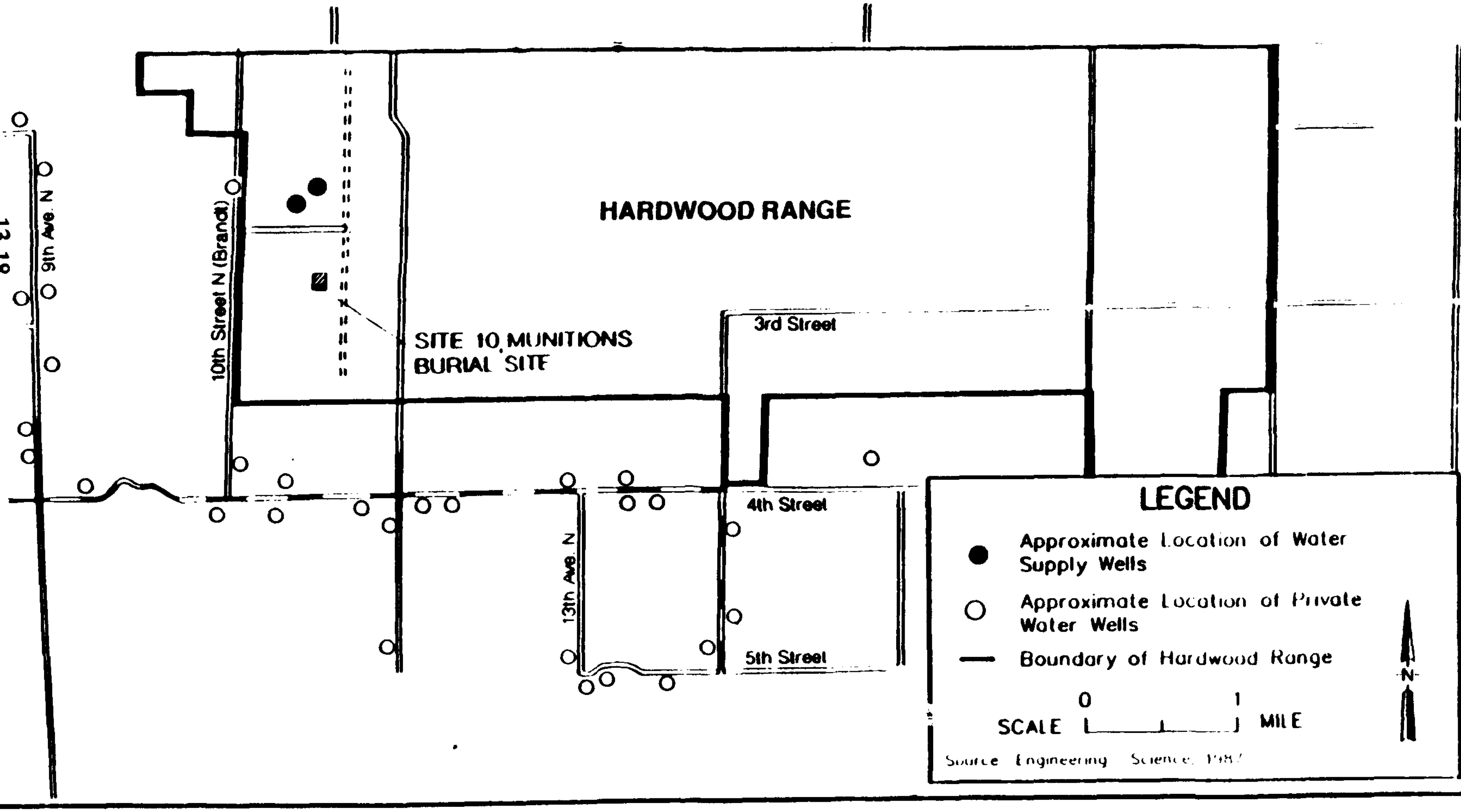

SITE 10, MUNITION
HYDROGEOLOGIC CROS
VOLK FIELD ANC
C
VF10 MW-1
VF10 MW-2
VF10 MW-4
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
960
955
950
945
940
935
930
925
920
915
910
905
900
895
890
SILTY SAND
LEGEND
Silt
Sand
Clay
Screened Interval
Estimated Topographic Surface
Water Table measured on 13 November 1990
General Direction of Groundwater Flow
The Above Lithologies May Occur Together.
SCALE 0 50 100 FEET
Source: Hazwrap 1990



ES ENGINEERING–SCIENCE

Figure 13.5

SITE 10, MUNITIONS BURIAL SITE
APPROXIMATE LOCATION OF WELLS
VOLK FIELD ANGB, WI



Source: Engineering-Science, 1987

Figure 13.6

SITE 10, MUNITIONS BURIAL SITE
VOCS DETECTED IN GROUNDWATER SAMPLES
VOLK FIELD ANGB, WI

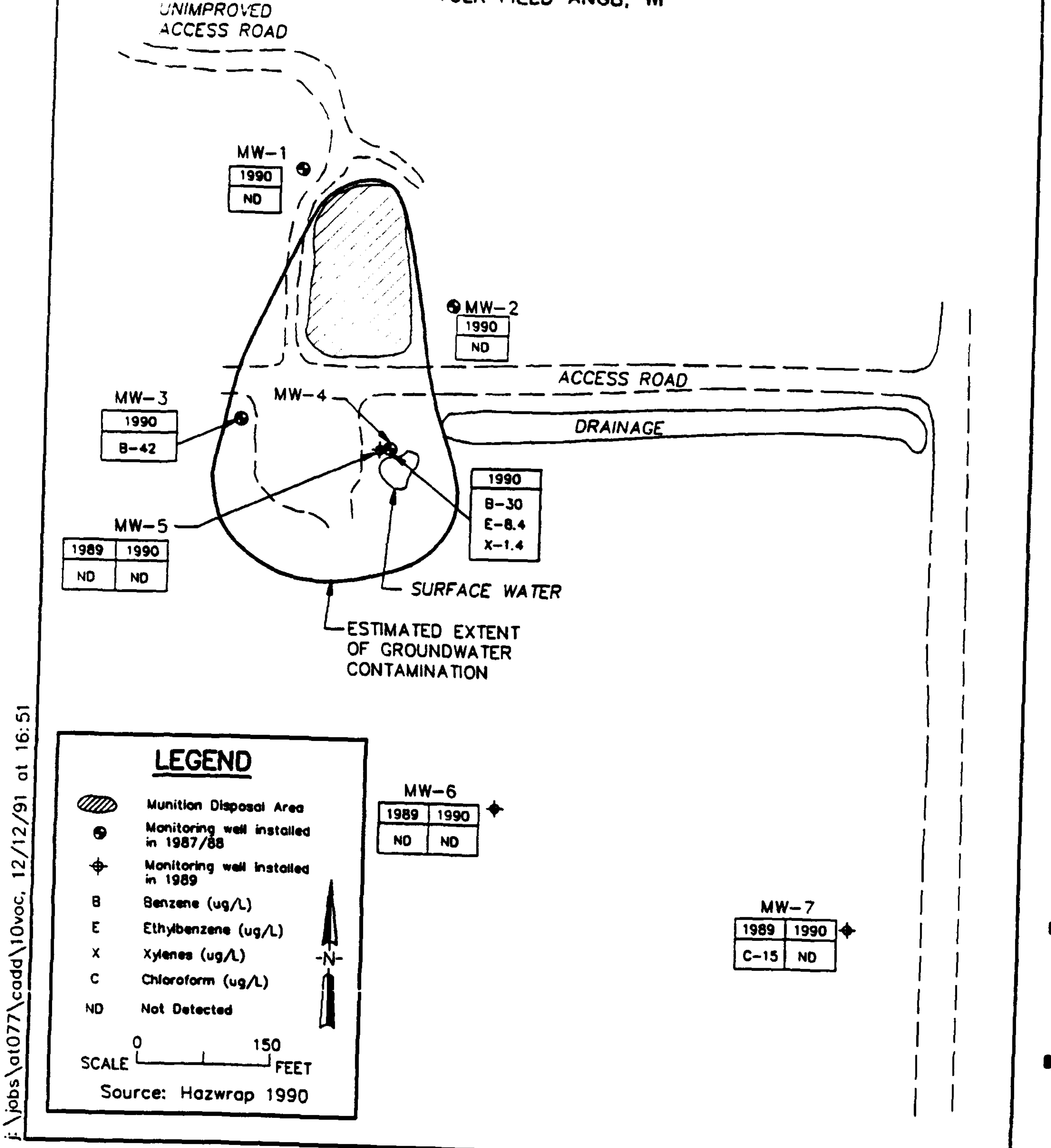


TABLE 13.1
SITE 10, MUNITION BURIAL SITE
DETECTED ANALYTES IN SOIL SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameter	VF10-SB1 (0'-1')*	VF10-SB2 (0'-1')*	VF10-SB3 (0'-1')*
Date Sampled	10/28/90	10/28/90	10/28/90
Halogenated Volatiles - SW8010 (ug/kg)	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/kg)	ND	ND	ND
Organochlorine Pesticides & PCB's CLP SOW (ug/kg)	ND	ND	ND
Semivolatile Organics - CLP SOW (ug/kg)	ND	ND	ND
13 Priority Pollutant Metals (mg/kg)			
Chromium	1.3	3.1	2.6
Copper	1.9	2.3	2.3
Nickel	1.5	1.9	1.5
Zinc	3.3	5.7	3.7
Mercury	0.011	U	U
Lead	U	1.1	U

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
* Incorrectly labeled as 1-2' on the chain-of-custody.

TABLE 13.2
SITE 10, MUNITIONS BURIAL SITE
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF10-MW5	VF10-MW6	VF10-MW7	VF10-MW20(a)
Date Sampled	11/06/89	11/10/89	11/06/89	11/06/89
Halogenated Volatiles - SW8010 (ug/L)				
Chloroform	1.3U	1.4U	15.0	1.4U
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	U	U	U	U
Total Dissolved Solids E160.1 (mg/L)	170	78	91	180
Semivolatiles (CLP-SOW) (ug/L)				
bis(2-ethylhexyl)phthalate	UJ2,J3	UJ2	UJ2,J3	12J2,J3
13 Priority Pollutant Metals (ug/L)				
Zinc	35	12	35	59

(a) - Duplicate for VF10-MW5.
ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.

TABLE 13.3
SITE 10, MUNITION BURIAL SITE
DETECTED ANALYTES IN GROUNDWATER SAMPLES, 1990
VOLK FIELD ANGB, WI

Parameter	VF10 MW1	VF10 MW2	VF10 MW3	VF10 MW8(a)	VF10 MW4	VF10 MW5	VF10 MW6	VF10 MW7
Date Sampled	10/28/90	10/28/90	10/28/90	10/28/90	10/28/90	10/28/90	10/28/90	10/28/90
Halogenated Volatiles – SW8010 (ug/L)	ND	ND	ND	ND	ND	ND	ND	ND
Aromatic Volatiles – SW8020 (ug/L)								
Benzene	U	U	42	41	30	UJ3	UJ3	U
Ethylbenzene	U	U	U	U	8.4	UJ3	UJ3	U
Xylenes	U	U	U	1.4	1.4	UJ3	UJ3	U
Total Petroleum Hydrocarbons E418.1 (mg/L)	1.1	3.5	U	1.0	U	U	U	U
Semivolatile Organics – CLP SOW (ug/L)	ND	ND	ND	ND	ND	ND	ND	ND
13 Priority Pollutant Metals (ug/L)								
Zinc	U	13.2J4	U	11.0J4	U	U	14.5J4	16.6J4
Total Dissolved Solids E160.1 (mg/L)	47	25	57	54	87	120	35	22

ND – No analytes detected for this method.
U – Below the detection limit.
J2, J3, J4 – Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.
(a) – Duplicate for VF10–MW3.

TABLE 13.4
SITE 10, MUNITIONS BURIAL SITE
DETECTED ANALYTES IN SUFACE WATER SAMPLES, 1989
VOLK FIELD ANGB, WI

Parameter	VF10-SW1	VF10-SW2	VF10-SW4
Date Sampled	11/06/89	11/06/89	11/06/89
Halogenated Volatiles - SW8010 (ug/L)	ND	ND	ND
Aromatic Volatiles - SW8020 (ug/L)	ND	ND	ND
Total Petroleum Hydrocarbons E418.1 (mg/L)	2.8	U	U
Total Dissolved Solids E160.1 (mg/L)	78	78	100
Semivolatile Organics - COP SOW (ug/L)			
bis(2-ethylhexyl)phthalate	UJ2	35J2	UJ3
ICP Dissolved Metals - SW6010 (ug/L)	ND	ND	ND

ND - No analytes detected for this method.
U - Below the detection limit.
J2, J3, J4 - Estimated result. Detailed explanation in Appendix E.
Priority Pollutant Metals: Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Tl, and Zn.
Analytical methods found in Section 3.

TABLE 13.5
SITE 10, MUNITIONS BURIAL SITE
CHEMICALS OF CONCERN DETECTED IN GROUNDWATER
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	95% Upper Confidence Limit (a) (mg/L)
Benzene	0.030-0.167	5 / 15	2.65E-02	4.81E-02	5.31E-02
bis(2-ethylhexyl)phthalate	0.012	1 / 15	4.17E-03	2.98E-03	5.82E-03
Chloroform	0.015	1 / 15	1.38E-03	3.65E-03	3.40E-03
Ethylbenzene	0.084-0.0166	3 / 15	3.23E-03	5.53E-03	6.29E-03
Naphthalene	0.002	2 / 15	4.07E-03	1.57E-03	4.94E-03
Petroleum Hydrocarbons (b)	1-3.5	2 / 15	7.33E-01	7.50E-01	1.15E+00
Toluene	0.100-0.149	2 / 15	1.71E-02	4.31E-02	4.09E-02
Xylene	0.0014-0.0587	4 / 15	7.57E-03	1.76E-02	1.73E-02
Zinc (Dissolved)	0.011-0.059	8 / 11	1.92E-02	1.62E-02	3.01E-02

(a) 95% Upper Confidence Limit of Arithmetic Mean = mean + t(s/sqrt n), where t is a value taken from Student's T distribution (alpha = 0.025 in each tail, n-1 degrees of freedom), s = standard deviation, sqrt = square root, n = sample size.

(b) A concentration of 1.1 mg/L was detected in the upgradient well.

TABLE 13.6
SITE 10, MUNITIONS BURIAL SITE
CHEMICALS OF CONCERN DETECTED IN SURFACE WATER
VOLK FIELD ANGB, WI

Chemical	Range Of Detected Concentration (mg/L)	Detection Frequency	Arithmetic Average Concentration (mg/L)	Standard Deviation (mg/L)	Maximum Detected Concentration (a) (mg/L)
bis(2-ethylhexyl)phthalate	0.035	1 / 2	2.00E-02	1.50E-02	3.50E-02
Petroleum Hydrocarbons	2.8	1 / 2	1.65E+00	1.15E+00	2.80E+00

(a) Sample size is less than 5 ($n < 5$), so the maximum detected concentration is presented instead of the 95% UCL.

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TABLE 13.7

SITE 10, MUNITION BURIAL SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
CURRENT USE SCENARIOS					
Air	Contaminated soils/volatilization, fugitive dust generation	Site 10; areas downwind	Onsite workers, nearby residents	Inhalation	None. No contaminants were detected in the soils.
Groundwater	Contaminated soils/leaching to groundwater	Water supply wells at Site 10	Onsite workers	Oral, dermal, inhalation	None. These wells are upgradient of the munitions burial area.
		Downgradient wells	Nearby residents	Oral, dermal, inhalation	Low. Low concentrations of contaminants were detected in monitoring wells immediately downgradient of site 10. The nearest private well is 1 mile away.
Surface Water	Contaminated soils, groundwater/ site runoff, groundwater seepage	Wetland area in vicinity of site, drainage areas onsite	Onsite workers	Oral, dermal, inhalation	Unlikely. No contaminants were detected in soils samples. One surface water sample contained petroleum hydrocarbons. No other chemicals were detected in surface water samples.
	Contaminated soil, groundwater/site runoff, groundwater seepage	Cranberries grown in fields next to site which might receive runoff water from the site	People who eat the cranberries	Oral	Unlikely. No compounds with reference toxicity information were detected in surface drainage areas on site. No contaminants were detected in soils.
Soils	Contaminated groundwater soil/ site runoff, leaching, tracking	Site 10	Onsite workers	Oral, dermal	None. No contaminants were detected in soil samples

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TABLE 13.7-Continued

SITE 10, MUNITION BURIAL SITE
MATRIX OF POTENTIAL EXPOSURE PATHWAYS
VOLK FIELD ANGB, WI

Transport Medium	Source/Release Mechanism	Primary Exposure Point	Potential Receptors	Primary Exposure Route(s)	Probability of Pathway Completion
FUTURE USE SCENARIOS					
Air	Contaminated soils/volatilization, fugitive dust generation	Site 10; areas downwind	Future residents, onsite workers	Inhalation	None. No Contaminants were detected in soils.
Groundwater	Contaminated soils/leaching	Wells onsite or downgradient	Future residents, onsite workers	Oral, dermal, inhalation	Low. Contaminants have been detected in groundwater downgradient of the site.
Surface Water	Contaminated soil, groundwater/ site runoff, groundwater seepage	Wetland area	Future residents, onsite workers	Oral, dermal, inhalation	Unlikely. No contaminants were detected in soil samples. One surface water sample contained petroleum hydrocarbons. No other chemicals were detected in surface water samples.
Soils	Contaminated soil, groundwater/ leaching, runoff, tracking	Site 10	Future residents, onsite workers	Oral, dermal	None. No soil contamination has been detected.

TABLE 13.8
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR INGESTION OF
GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	5.31E-02	1.10E-02	5.85E-04	2.90E-02	1.70E-05
bis(2-ethylhexyl)phthalate	5.82E-03	1.10E-02	6.40E-05	1.40E-02	8.97E-07
Chloroform	3.40E-03	1.10E-02	3.74E-05	6.10E-03	2.28E-07
				CARCINOGENIC RISK =	2E-05

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.

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TABLE 13.9
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	5.31E-02	1.28E-01	6.80E-03	ND	NA
bis(2-ethylhexyl)phthalate	5.82E-03	1.28E-01	7.45E-04	2.00E-02	3.73E-02
Chloroform	3.40E-03	1.28E-01	4.35E-04	1.00E-02	4.35E-02
Ethylbenzene	6.29E-03	1.28E-01	8.05E-04	1.00E-01	8.05E-03
Naphthalene	4.94E-03	1.28E-01	6.32E-04	4.00E-03	1.58E-01
Petroleum Hydrocarbons	1.15E+00	1.28E-01	1.47E-01	ND	NA
Toluene	4.09E-02	1.28E-01	5.24E-03	2.00E-01	2.62E-02
Xylene	1.73E-02	1.28E-01	2.21E-03	2.00E+00	1.11E-03
Zinc	3.01E-02	1.28E-01	3.85E-03	2.00E-01	1.92E-02
				HAZARD INDEX =	3E-01

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 13.10
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	5.31E-02	3.49E-03	1.85E-04	2.90E-02	5.38E-06
bis(2-ethylhexyl)phthalate	5.82E-03	3.49E-03	2.03E-05	1.40E-02	2.84E-07
Chloroform	3.40E-03	3.49E-03	1.19E-05	6.10E-03	7.23E-08
				CARCINOGENIC RISK =	6E-06

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 13.11
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY WORKERS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	5.31E-02	9.78E-03	5.20E-04	ND	NA
bis(2-ethylhexyl)phthalate	5.82E-03	9.78E-03	5.69E-05	2.00E-02	2.85E-03
Chloroform	3.40E-03	9.78E-03	3.32E-05	1.00E-02	3.32E-03
Ethylbenzene	6.29E-03	9.78E-03	6.15E-05	1.00E-01	6.15E-04
Naphthalene	4.94E-03	9.78E-03	4.83E-05	4.00E-03	1.21E-02
Petroleum Hydrocarbons	1.15E+00	9.78E-03	1.12E-02	ND	NA
Toluene	4.09E-02	9.78E-03	4.00E-04	2.00E-01	2.00E-03
Xylene	1.73E-02	9.78E-03	1.69E-04	2.00E+00	8.46E-05
Zinc	3.01E-02	9.78E-03	2.94E-04	2.00E-01	1.47E-03
				HAZARD INDEX =	2E-02

(a) Based on concentrations in onsite, downgradient wells.

(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.

(c) Intake variables are not adjusted for absorption.

ND - Not Determined

NA - Not Applicable

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TABLE 13.12
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	5.31E-02	1.17E-02	6.22E-04	2.90E-02	1.80E-05
bis(2-ethylhexyl)phthalate	5.82E-03	1.17E-02	6.81E-05	1.40E-02	9.54E-07
Chloroform	3.40E-03	1.17E-02	3.98E-05	6.10E-03	2.42E-07
			CARCINOGENIC RISK =		2E-05

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.

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TABLE 13.13
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
Benzene	5.31E-02	2.74E-02	1.46E-03	ND	NA
bis(2-ethylhexyl)phthalate	5.82E-03	2.74E-02	1.60E-04	2.00E-02	7.98E-03
Chloroform	3.40E-03	2.74E-02	9.31E-05	1.00E-02	9.31E-03
Ethylbenzene	6.29E-03	2.74E-02	1.72E-04	1.00E-01	1.72E-03
Naphthalene	4.94E-03	2.74E-02	1.35E-04	4.00E-03	3.38E-02
Petroleum Hydrocarbons	1.15E+00	2.74E-02	3.15E-02	ND	NA
Toluene	4.09E-02	2.74E-02	1.12E-03	2.00E-01	5.61E-03
Xylene	1.73E-02	2.74E-02	4.74E-04	2.00E+00	2.37E-04
Zinc	3.01E-02	2.74E-02	8.24E-04	2.00E-01	4.12E-03
				HAZARD INDEX =	6E-02

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 13.14
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	5.31E-02	6.70E-06	3.56E-07	2.90E-02	1.03E-08
bis(2-ethylhexyl)phthalate	5.82E-03	6.70E-06	3.90E-08	1.40E-02	5.46E-10
Chloroform	3.40E-03	6.70E-06	2.28E-08	6.10E-03	1.39E-10
				CARCINOGENIC RISK =	1E-08

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.

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TABLE 13.15
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	5.31E-02	7.82E-05	4.16E-06	ND	NA
bis(2-ethylhexyl)phthalate	5.82E-03	7.82E-05	4.55E-07	2.00E-02	2.28E-05
Chloroform	3.40E-03	7.82E-05	2.66E-07	1.00E-02	2.66E-05
Ethylbenzene	6.29E-03	7.82E-05	4.92E-07	1.00E-01	4.92E-06
Naphthalene	4.94E-03	7.82E-05	3.86E-07	4.00E-03	9.65E-05
Petroleum Hydrocarbons	1.15E+00	7.82E-05	8.98E-05	ND	NA
Toluene	4.09E-02	7.82E-05	3.20E-06	2.00E-01	1.60E-05
Xylene	1.73E-02	7.82E-05	1.35E-06	2.00E+00	6.76E-07
Zinc	3.01E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	2E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 13.16
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor (d) 1/(mg/kg/day)	Chemical-Specific Risk
Benzene	5.31E-02	1.91E-05	1.01E-06	2.90E-02	2.94E-08
bis(2-ethylhexyl)phthalate	5.82E-03	1.91E-05	1.11E-07	1.40E-02	1.56E-09
Chloroform	3.40E-03	1.91E-05	6.49E-08	6.10E-03	3.96E-10
			CARCINOGENIC RISK =		3E-08

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.

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TABLE 13.17
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR DERMAL ABSORPTION FROM GROUNDWATER BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/l)	Intake Variable (c) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (d) (mg/kg/day)	Hazard Quotient
Benzene	5.31E-02	4.46E-05	2.37E-06	ND	NA
bis(2-ethylhexyl)phthalate	5.82E-03	4.46E-05	2.60E-07	2.00E-02	1.30E-05
Chloroform	3.40E-03	4.46E-05	1.52E-07	1.00E-02	1.52E-05
Ethylbenzene	6.29E-03	4.46E-05	2.80E-07	1.00E-01	2.80E-06
Naphthalene	4.94E-03	4.46E-05	2.20E-07	4.00E-03	5.50E-05
Petroleum Hydrocarbons	1.15E+00	4.46E-05	5.12E-05	ND	NA
Toluene	4.09E-02	4.46E-05	1.83E-06	2.00E-01	9.13E-06
Xylene	1.73E-02	4.46E-05	7.71E-07	2.00E+00	3.86E-07
Zinc	3.01E-02	NA (e)	NA	2.00E-01	NA
				HAZARD INDEX =	1E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Intake variables are adjusted for dermal absorption.
(d) Oral value is used: assumes 100% oral absorption.
(e) Dermal absorption for metals = 0.
ND - Not Determined
NA - Not Applicable

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TABLE 13.18
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR INGESTION OF
SURFACE WATER BY CHILDREN
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (a) (mg/l)	Intake Variable (b) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
bis(2-ethylhexyl)phthalate	3.50E-02	2.19E-03	7.67E-05	1.40E-02	1.07E-06
			CARCINOGENIC RISK =		1E-06

(a) Concentration in surface water represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.

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TABLE 13.19
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE WATER BY CHILDREN
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
bis(2-ethylhexyl)phthalate	3.50E-02	1.88E-04	6.58E-06	2.00E-02	3.29E-04
Petroleum Hydrocarbons	2.80E+00	1.88E-04	5.26E-04	ND	NA
				HAZARD INDEX =	3E-04

(a) Concentration in surface water represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.
ND - Not Determined
NA - Not Applicable

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TABLE 13.20
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK FOR INGESTION OF
SURFACE WATER BY ADULT RESIDENTS
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (a) (mg/l)	Intake Variable (b) (l/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral Slope Factor 1/(mg/kg/day)	Chemical-Specific Risk
bis(2-ethylhexyl)phthalate	3.50E-02	2.01E-04	7.04E-06	1.40E-02	9.85E-08
			CARCINOGENIC RISK =		1E-07

(a) Concentration in surface water represents the maximum detected concentration.
(b) Intake variables are not adjusted for absorption.

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TABLE 13.21
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX FOR INGESTION OF SURFACE WATER BY ADULT RESIDENTS
VOLK FIELD ANGB, WI

Chemical	Concentration In Surface Water (a) (mg/kg)	Intake Variable (b) (kg soil/kg-day)	Chronic Daily Intake (mg/kg-day)	Oral RfD (mg/kg/day)	Hazard Quotient
bis(2-ethylhexyl)phthalate	3.50E-02	4.70E-04	1.65E-05	2.00E-02	8.23E-04
Petroleum Hydrocarbons	2.80E+00	4.70E-04	1.32E-03	ND	NA
				HAZARD INDEX =	8E-04

(a) Concentration in surface water represents the maximum detected concentration.

(b) Intake variables are not adjusted for absorption.

ND - Not Determined

NA - Not Applicable

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TABLE 13.22
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM
GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	5.31E-02	5.43E-03	3.38E+00	8.3E-06	2.8E-05
Chloroform	3.40E-03	3.20E-03	1.27E-01	2.3E-05	2.9E-06
				CARCINOGENIC RISK =	3E-05

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 13.23
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY CHILDREN (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	5.31E-02	5.43E-03	3.94E-02	ND	NA
Chloroform	3.40E-03	3.20E-03	1.49E-03	ND	NA
Ethylbenzene	6.29E-03	8.44E-03	7.25E-03	1.0E+00	7.25E-03
Toluene	4.09E-02	5.94E-03	3.32E-02	2.0E+00	1.66E-02
Xylene	1.73E-02	5.10E-03	1.20E-02	3.0E-01	4.01E-02
				HAZARD INDEX	6E-02

(a) Based on concentrations in onsite, downgradient wells.

(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.

(c) Derived from groundwater concentration via shower model presented in Section 4.

ND - Not Determined

NA - Not Applicable

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TABLE 13.24
SITE 10, MUNITIONS BURIAL SITE
CARCINOGENIC RISK ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (ug/m3) (c)	Inhalation Unit Risk 1/(ug/m3)	Chemical-Specific Risk
Benzene	5.31E-02	5.43E-03	1.69E+01	8.3E-06	1.4E-04
Chloroform	3.40E-03	3.20E-03	6.37E-01	2.3E-05	1.5E-05
				CARCINOGENIC RISK =	2E-04

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.

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TABLE 13.25
SITE 10, MUNITIONS BURIAL SITE
NONCARCINOGENIC HAZARD INDEX ASSOCIATED WITH VOCs RELEASED FROM GROUNDWATER DURING SHOWERING BY ADULT RESIDENTS (a)
VOLK FIELD ANGB, WI

Chemical	Concentration In Groundwater (b) (mg/L)	Henry's Law Constant (m3-atm/mol)	Air Concentration (mg/m3) (c)	RfC (mg/m3)	Hazard Quotient
Benzene	5.31E-02	5.43E-03	3.94E-02	ND	NA
Chloroform	3.40E-03	3.20E-03	1.49E-03	ND	NA
Ethylbenzene	6.29E-03	8.44E-03	7.25E-03	1.0E+00	7.25E-03
Toluene	4.09E-02	5.94E-03	3.32E-02	2.0E+00	1.66E-02
Xylene	1.73E-02	5.10E-03	1.20E-02	3.0E-01	4.01E-02
				HAZARD INDEX	6E-02

(a) Based on concentrations in onsite, downgradient wells.
(b) Concentration in groundwater represents the 95th percent upper confidence limit for the arithmetic mean.
(c) Derived from groundwater concentration via shower model presented in Section 4.
ND - Not Determined
NA - Not Applicable

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TABLE 13.26
SITE 10, MUNITIONS BURIAL SITE
SUMMARY OF CANCER RISKS
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Pathway Risk	Main Contributing Compound
Future Onsite Workers	Ingestion of Groundwater	6E-06	Benzene
Future Adult Residents	Ingestion of Groundwater	2E-05	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	2E-04	Benzene
	Dermal Absorption from Groundwater	3E-08	Benzene
	Incidental Ingestion of Surface Water	1E-07	Bis(2-ethylhexyl)phthalate
Future Children	Ingestion of Groundwater	2E-05	Benzene
	Inhalation of VOCs Released from Groundwater during Showering	3E-05	Benzene
	Dermal Absorption from Groundwater	1E-08	Benzene
	Incidental Ingestion of Surface Water	1E-06	Bis(2-ethylhexyl)phthalate

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TABLE 13.27
SITE 10, MUNITIONS BURIAL SITE
SUMMARY OF HAZARD INDICES
VOLK FIELD ANGB, WI

Receptor	Exposure Pathway	Hazard Index	Main Contributing Compound
Future Onsite Workers	Ingestion of Groundwater	2E-02	Naphthalene
Future Adult Residents	Ingestion of Groundwater	6E-02	Naphthalene, Chloroform
	Inhalation of VOCs Released from Groundwater during Showering	6E-02	Xylene
	Dermal Absorption from Groundwater	1E-04	Naphthalene
	Incidental Ingestion of Surface Water	8E-04	Bis(2-ethylhexyl)phthalate
Future Children	Ingestion of Groundwater	3E-01	Naphthalene
	Inhalation of VOCs Released from Groundwater during Showering	6E-02	Xylene
	Dermal Absorption from Groundwater	2E-04	Naphthalene
	Incidental Ingestion of Surface Water	3E-04	Bis(2-ethylhexyl)phthalate

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TABLE 13.28
CHEMICAL CONSTITUENTS DETECTED AT SITE 10 AND CORRESPONDING ARARs VOLK FIELD ANGB, WI

Chemical	Year Detected	Maximum Detected Concentration	Criterion Used	Criterion Value	Detected Concentration Exceeds Criterion
Soil (mg/kg)					
Chromium (VI)	1990	3.1	--	--	--
Copper	1990	2.3	--	--	--
Lead	1990	1.1	--	--	--
Nickel	1990	1.9	--	--	--
Mercury	1990	0.011	--	--	--
Zinc	1990	5.7	--	--	--
Groundwater (ug/L)					
Benzene	1988, 1990	167	MCL/WIDNR	5	Yes
Bis(2-ethylhexyl)phthalate	1989	12	--	--	--
Chloroform	1989	15	WIDNR	6	Yes
Ethylbenzene	1988, 1990	16.6	MCL	700	No
Lead	1988	8(1)	MCL	15	No
Naphthalene	1988	2	--	--	--
TDS	1989, 1990	180,000	--	--	--
Toluene	1988	149	WIDNR	343	No
TPH	1990	3,500	--	--	--
Xylenes	1988, 1990	58.7	WIDNR	620	No
Zinc	1989, 1990	59	MCL/WIDNR	5,000	No
Surface Water (ug/L)					
Bis(2-ethylhexyl)phthalate	1989	35	FAWQC (HH)	5.9	Yes
TDS	1989	100,000	--	--	--
TPH	1989	2,800	--	--	--

MCL - Safe Drinking Water Act Maximum Contaminant Level.
WIDNR - Wisconsin Department of Natural Resources Enforcement Standard.
FAWQC (HH) - Federal Ambient Water Quality Criterion for Human Health, consumption of organisms.
(1) - Unfiltered sample; detected concentration not used in risk assessment.

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SECTION 14
SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

In this section a summary of the major findings, conclusions and recommendations is included for each of the ten sites investigated under the IRP. Also included is a summary of results obtained from the sampling of the Base Production wells. The site summaries include a brief discussion of the site setting, objectives of the RI or SI phase of work, activities conducted, risk assessment, extent of contamination, and recommendations for follow-on studies if needed.

A brief discussion of ARARs compliance is also provided. The discussion contains ARARs exceeded by compounds detected since 1987. Previous reports [ES, 1990b, 1990c] provide complete details of prior investigations at these sites.

SITE 1 - FIRE TRAINING AREA

Site 1 is located near the intersection of Madison Boulevard and Bluff Road. The fire training activities at the site began in the 1940s and ended in 1980 and consisted of the burning of flammable liquids. In 1987, the areal extent of soil contamination around the fire training pit was defined from soil borings. Groundwater samples from four monitoring wells installed in 1987 along with samples from wells previously installed were collected to define groundwater contamination. Activities performed during 1989 included a geophysical survey, a soil gas survey, collection of soil samples, and the installation and sampling of additional monitoring wells. Activities in 1990 included the installation of four monitoring wells and collection of groundwater samples. The 1991 field effort consisted of product sampling, two product bail-down tests and the installation of one temporary monitoring well.

Groundwater is approximately 15 feet BLS and flows toward the northeast at a rate of 1.76 ft/day. Volatiles, semivolatiles and inorganics were detected in soils and groundwater at the site. Soils in the fire training pit are a continuing source for groundwater contamination. Free product was detected in seven of the wells located within the fire training pit. The results of a bail-down test indicated that the actual thickness of product on the water table beneath the fire training pit is about 2 inches. The amount of recoverable product was estimated to be between 100 and 550 gallons. The extent and magnitude of groundwater contamination (including free product) has been defined.

ARARs exceeded at this site include Wisconsin Enforcement Standards and Federal MCLs. Compounds detected in groundwater which exceeded ARARs include benzene, pentachlorophenol, toluene, TCE, xylene, and lead.

The human health evaluation indicated that the risks associated with the soils were acceptable for all receptors. Carcinogenic risks associated with ingestion of groundwater were found to be unacceptable for all receptors due primarily to the presence of benzene, bis(2-ethylhexyl)phthalate, and pentachlorophenol. Unacceptable noncarcinogenic risks associated with ingestion of groundwater were also found for children due primarily to the presence of bis(2-ethylhexyl)phthalate; 1,3-dichloropropene; naphthalene; and toluene. For children and adults, carcinogenic and noncarcinogenic risks associated with inhalation of volatiles from groundwater were found to be unacceptable primarily due to the presence of benzene, toluene and xylene. However, the groundwater exposure pathways at this site are for hypothetical (future) residents and are not currently complete. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

It is recommended the product at Site 1 be removed periodically by bailing select wells as an intermediate response until a final remedial alternative is in place. The contamination in the soils at Site 1 is a source of groundwater contamination beneath the site. It is recommended that an FS be conducted to address potential remedial actions for both the soil and groundwater contamination. During the FS and subsequent RD, additional information on the site may be required. The collection of contaminated soils may be required to assess characteristics pertinent to the treatment processes under consideration. Extraction and treatment will be considered for groundwater remediation; therefore, additional aquifer testing may be required.

SITE 2 - FORMER LANDFILL C

Site 2 is located in the southeastern corner of the Base. This landfill has not been utilized since June 1984. The fill area is aboveground and waste is visible on the surface of the northern lobe of the landfill and in the sides of the southern lobe. Field investigations performed in 1987 included geophysical surveys, monitoring well installation and water sampling. An additional well was installed in 1989. In 1990, field activities performed at the site included exploratory hand augering and sampling of groundwater, surface water and soils. Sediment samples were obtained in 1991.

The groundwater flow potential is upward with a vertical hydraulic gradient of 0.0027 ft/ft. The upward gradient and the potentiometric surface found at or above the ground surface implies that the site is in a groundwater discharge area (swamp). The only organic compound detected in the groundwater samples collected at this site was bis(2-ethylhexyl)phthalate, which was detected in the upgradient well.

Several inorganic compounds were detected in unfiltered groundwater samples. Only inorganics were detected in the sediments and surface water samples collected. PAHs and pesticides were detected in soil samples collected from borings advanced into the top of the landfill.

ARARs exceeded at this site for surface waters include federal criteria for protection of freshwater aquatic life and the Wisconsin surface water criteria. Compounds detected in surface water which exceeded ARARs include lead, mercury, thallium and zinc. However, each of these metals was present in an upstream location and is not thought to be present as a result of activities at this site. Criteria for groundwater were not exceeded. ARARS for soil and sediment were not identified.

The pathways for exposure considered at Site 2 included the incidental ingestion of surface soils, dermal contact with surface soils, ingestion of sediments and ingestion of surface waters. All carcinogenic and noncarcinogenic risks were found to be acceptable. Therefore, no adverse health effects are expected to occur at this site and the risks to ecological receptors from lead and DDT at Site 2 appear low. It is, therefore, recommended that a No-Further-Action Decision Document be prepared for this site.

SITE 3/6 - FUEL SPILL SITE

Routine spills of JP-4 and AVGAS have reportedly occurred at Site 3 over the past 30 years. Approximately 3,500 gallons of JP-4 were lost from one of the two aboveground storage tanks at Site 6. In 1987, an SI including a soil gas survey and installation of one monitoring well was conducted at Site 3/6. In 1989, five monitoring wells were installed and sampled. The field activities in 1990 included soil sampling, exploratory hand augering, the installation of monitoring wells and groundwater sampling. During the 1990 investigation, an increase in contamination was observed in monitoring well VF3/6 MW-1. Additional exploratory hand augering was conducted in 1991.

The depth to groundwater is approximately 10 feet BLS and flow is toward the northeast at a rate of 0.07 ft/day. Volatiles and TPH were detected in soils which serve as a continuous source of groundwater contamination. The magnitude and extent of this groundwater contamination at Site 3/6 has been evaluated. The areal extent of contamination appears to be greatest downgradient of the fuel handling area (Site 3). A thin layer of free floating product is present on the water table in the area of Building 33. Well MW-8 is located downgradient of the area where free floating product was encountered. Groundwater from this well had the highest detected level of benzene. Well MW-2, further downgradient of this location, is not contaminated. Significant groundwater contamination was detected in the area of the aboveground tank fuel spill area. Limited hand augering in this area in 1991

indicate that a source for this contamination may be located below the aboveground tanks. A well cluster downgradient of this location is not contaminated.

Groundwater ARARs exceeded at this site include Wisconsin Enforcement Standards and Federal MCLs. Compounds detected in groundwater which exceeded ARARs include benzene, toluene, and xylenes. ARARs for soils were not identified.

The human health evaluation indicated the risk associated with soils were acceptable. Carcinogenic risks associated with ingestion of groundwater and inhalation of volatiles released from groundwater during showering were found to be unacceptable for hypothetical residents. These risks are due to the presence of benzene. Noncarcinogenic risks associated with ingestion of groundwater and inhalation of VOCs released from groundwater during showering were found to be unacceptable for hypothetical residents. It is noted, however, that pathways associated with groundwater at this site are not considered complete at this time. This pathway could become complete only if contaminants were to migrate to downgradient drinking water wells or if a drinking water well were installed at the site.

It is recommended, given the contaminant concentration in the soils at Site 3, action should be undertaken to remove these sources of groundwater contamination. The source of contamination at Site 6 should be confirmed. If contaminant concentrations in the soils in this location are significant, action should also be undertaken to remove the source of groundwater contamination at this site. An FS should be conducted to address the soil and groundwater contamination across the site. The FS would assess potential remedial actions (including the no-action alternative). Additional soil sampling may be required to evaluate treatment options for soils remediation. Potential remedial alternatives including extraction and treatment should be considered for groundwater remediation. Additional aquifer testing may be required.

SITE 4 - TRANSFORMER FLUID DISPOSAL AREA

Site 4 is located under the asphalt parking lot about 100 feet south of Building 331. Fluid from approximately ten retired transformer drums may have been emptied onto the ground in 1967 or 1968. The disposal area was paved in 1977. During the 1987 SI, eight soil borings were drilled to obtain soil samples. In 1989, three additional soil borings were drilled for the collection of soil samples. Groundwater was not encountered during the drilling of any soil borings. No chemical contaminants were detected at Site 4. Field activities were not conducted in 1990 or 1991. No risks are associated with waste disposal activities at the site. A No-Further-Action Decision Document should be prepared for Site 4.

SITE 5 - KC97 CRASH SITE

Site 5 is located north of Taxiway 3 and parallel to the main runway. In 1978, JP-4 and AVGAS were released in this area as a result of a KC97 aircraft accident. In 1989, the field program included a soil gas survey, soil borings, monitoring well installation, and soil and groundwater sampling. In 1990, the monitoring well was resampled. Field activities were not conducted in 1991.

Toluene, xylene, lead, and TPH were detected in soils at the site; however, no groundwater contamination was detected. No unacceptable risks were identified by the human health evaluation. A No-Further-Action Decision Document should be prepared for Site 5.

SITE 7 - FORMER LANDFILL A

Site 7 is located immediately south of Madison Boulevard in the eastern portion of the Base. The landfill has not been used since the late 1940s or early 1950s, and the exact location of fill areas could not be determined from available records. However, the approximate location of the landfill was determined during the SI. The SI was conducted in 1987 and consisted of a geophysical survey and the installation and sampling of three monitoring wells. Additional monitoring wells were installed in 1989. In 1990 field activities included exploratory hand augering and groundwater sampling. Field activities were not conducted in 1991.

The depth to groundwater ranges from 9 to 33 feet BLS and the direction of flow is toward the northeast at a rate of 0.05 ft/day. ARARs exceeded at this site include Wisconsin Enforcement Standards and Federal MCLs. Compounds detected in groundwater which exceeded ARARs include arsenic, cadmium, chromium and lead. These four metals were all collected during the 1988 sampling effort are from unfiltered samples. Metal concentrations detected in filtered samples did not exceed ARARs. No unacceptable risks were identified by the human health evaluation conducted for this site; therefore a No-Further-Action Decision Document should be prepared for Site 7.

SITE 8 - F84 CRASH SITE

Site 8 is located at the western end of the east-west runway. The crash occurred around 1964 and may have generated a release of JP-4 fuel to the ground. In 1966, the runway was extended over the crash site. The work performed at the site in 1990 included a records search, soil borings, monitoring well and piezometer installation, and soil and groundwater sampling. Field activities were not conducted in 1991. No contaminants were detected in groundwater at Site 8. Lead was the only compound detected in soil samples collected at this site. The human health evaluation concluded that no unacceptable risks are associated with this site. A No-Further-Action Decision Document should be prepared for Site 8.

SITE 9 - FORMER LANDFILL B

Site 9 is directly south of Site 1. Materials disposed in this landfill may have included general refuse, lead, ammunition and possibly a C-47 aircraft. The discharge of fuel and burning of munitions may also have taken place. Surface evidence of the landfill does not exist. However, the approximate location of the landfill was determined during the SI. The 1987 SI included a geophysical survey and the installation and sampling of three monitoring wells. In 1989, additional geophysical surveys were conducted in conjunction with the survey at Site 1. Soil and groundwater samples were obtained in 1990. Field activities were not conducted in 1991.

Metals, semivolatiles and pesticides were detected in surface soils. BETX compounds were detected in groundwater at Site 9 during the SI [ES, 1990c]. Groundwater samples collected during this investigation contained only dissolved metals. ARARs exceeded at this site include Wisconsin Enforcement Standards and Federal MCLs. Compounds detected in groundwater which exceeded ARARs include cadmium and silver. Cadmium was detected in only one filtered groundwater sample while silver was detected in only one unfiltered groundwater sample. ARARs for soils were not identified.

The risk assessment performed for Site 9 indicated the only unacceptable health risk is due to the noncarcinogenic hazard to hypothetical (future) children from groundwater ingestion at the site. This risk was caused by the presence of cadmium. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

Considering that the risk associated with cadmium is for a currently incomplete pathway it is recommended the wells at this site be sampled two times over the next year to monitor for the presence of cadmium. The results obtained from this sampling should be evaluated using the risk assessment procedures presented in this document. If significant levels of cadmium are not detected a No-Further-Action Decision Document should be prepared for Site 9.

SITE 10 - MUNITIONS BURIAL SITE

Site 10 is located on the west side of Hardwood Range. From 1976 to 1988 this site was used for the burning and burial of spent munitions. In 1987, SI activities included the installation and sampling of four monitoring wells. The 1989 field activities included the installation of three monitoring wells and surface water and groundwater sampling. In 1990, soil and groundwater samples were collected. Field activities were not conducted in 1991.

Groundwater flow at the site is toward the south-southeast at a rate of 0.07 ft/day. Volatile and semivolatile organics and inorganic contaminants were detected in groundwater at Site 10. An increase in groundwater contamination was observed in monitoring well MW-3 and a decrease in groundwater contamination

was observed in MW-4 between 1988 and 1990. One surface water sample contained TPH and another contained phthalates. ARARs exceeded at this site include a Wisconsin Enforcement Standard, a Federal MCL, and Federal surface water criteria. Compounds detected in groundwater which exceeded ARARs include benzene and chloroform. Bis(2-ethylhexyl)phthalate in surface water exceeded corresponding federal criteria.

The risk assessment for this site indicated the only unacceptable health risk for this site was for inhalation of benzene from groundwater for hypothetical (future) adult residents during showering. This risk should be viewed in light of the relatively conservative set of assumptions used in the risk assessment (i.e., residential use of the site) and the marginal exceedance of EPA's acceptable risk range. Also, the groundwater exposure pathways at this site are for hypothetical (future) residents and are not currently complete. This pathway could become complete only if contaminants were to migrate to downgradient water supply wells or if a drinking water well were installed at the site.

It is recommended that an FS be conducted to determine the best alternative for mitigation of the contaminants identified at the site. Source control and long-term monitoring may be appropriate.

BASE PRODUCTION WELL

Three Base production wells were sampled for volatile and semivolatile organics, TPH and dissolved priority pollutant metals. No compounds were detected in samples from W-4, the well downgradient of Sites 1 and 7. Samples from W-1 contained copper, lead and zinc. Chloroform and lead were detected in samples from W-2.

ARARs exceeded for these wells include the Wisconsin Enforcement Standard for chloroform and the Federal Action Level for lead. It is noted wells W-1 and W-2 are not downgradient or associated with any sites under this investigation. The source of these compounds is unknown and should be investigated.

SECTION 15
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